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FOR MANAGEMENT

NOVEMBER 1958
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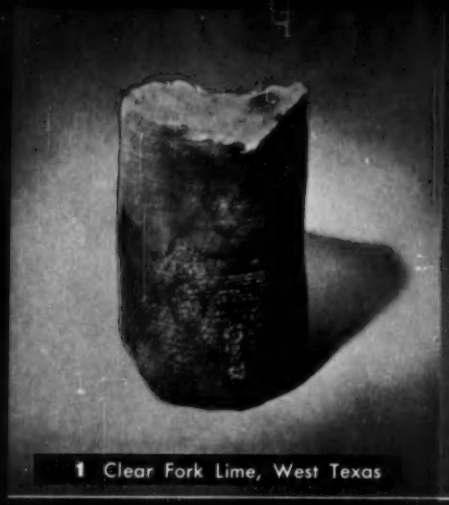
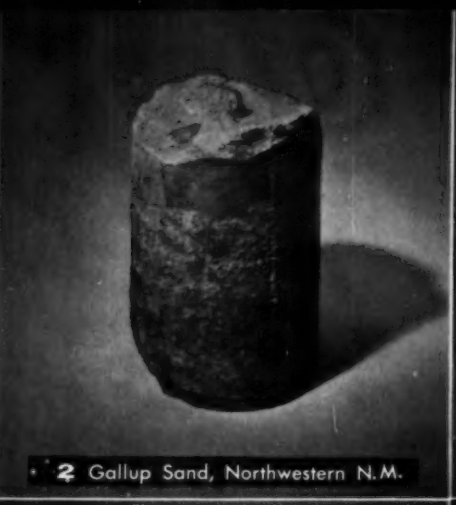
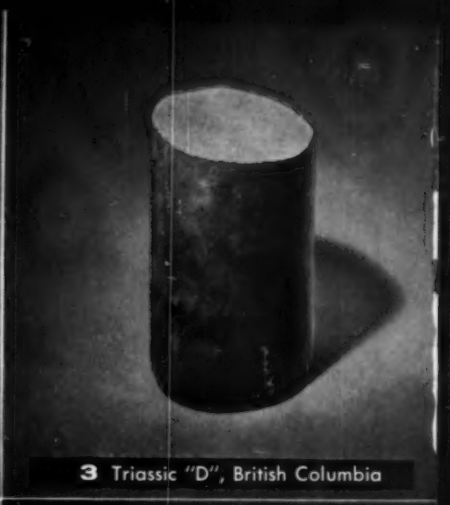


1 Clear Fork Lime, West Texas



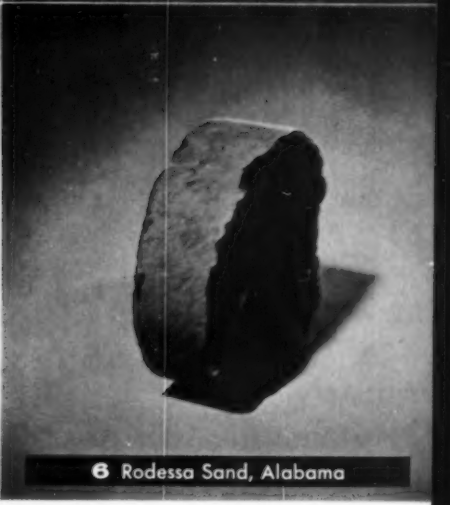
2 Gallup Sand, Northwestern N.M.



3 Triassic "D", British Columbia

4 Canyon Sand, North Texas

5 Wilcox Sand, South Texas



6 Rodessa Sand, Alabama

Dowell Guide To Fracturing

1 Clear Fork Lime, West Texas: This limestone contains varying amounts of dolomite and salt. Duofrac* has been quite successful — using large volumes of weak acid as a sand carrier. This fluid attacks both the formation and salt crystals. 50,000-gallon treatments, injection rates up to 50 bpm and ball sealers, are common. After treatment, some wells potential over 300 bopd.

2 Gallup Sand, Northwestern New Mexico: This core is from one of the better Bisti wells. Permeability is often less than one millidarcy and porosity ranges from zero to 12 per cent. Before treatment, wells often will not produce commercially. After a 500-gallon spearhead of Mud Acid, followed by Sandfrac* — using 50,000 gallons of lease crude and 50,000 pounds of sand at 30 to 40 bpm — many wells potential up to 600 bopd.

3 Triassic "D", British Columbia: This sandstone gas pay frequently produces commercially before fracturing. However, many operators have increased potentials by fracturing with Sandfrac*, using diesel oil with 100 pounds of FLA (Fluid Loss Agent) per 1,000 gallons. Treatments usually consist of 20,000 gallons fluid and 20,000 pounds sand down tubing at about 8 bpm. Results vary widely — with increases from two to 25 mmcfd being reported.

4 Canyon Sand, North Texas: Wells completed in this Pennsylvanian age formation often give high initial production (80 to 300 bopd). However, a steep decline curve to 8 or 10 bopd in six to nine months makes fracturing advisable. Usual treatment is a spearhead of 500 to 1,000 gallons of a special acid followed by Sandfrac* — using 10,000 to 20,000 gallons lease crude and 1½ pounds sand per gallon. FLA* (Fluid Loss Additive) is often used. Treatment generally increases production and reduces decline rate.

5 Wilcox Sand, South Texas: This shale-streaked sandstone is found from 8,000 to 11,000 feet. Bottom-hole temperature is high — from 225° to 300°F — and pay zones range from 15 to 200 feet in thickness. Stratafrac* is often used because it is designed to clean up fast and suspends sand well at high temperatures. Treatments range from 6,000 to 12,000 gallons injected at 3 to 5 bpm, with 1 pound of sand per gallon. Production frequently increases from less than 10 to 70 bopd through choke.

6 Rodessa Sand, Alabama: The Citronelle Field produces from two sections of dirty sand varying in depth from 10,400 to 11,600 feet. Super Mud Acid, with an added silicate control agent, is used to dissolve and shrink clays. Petrojel*, using 20,000 to 30,000 gallons jelled crude with 20,000 to 40,000 pounds sand is usually recommended. Ball sealers are frequently used to spread the effect of the treatment. Many wells then potential over 300 bopd.

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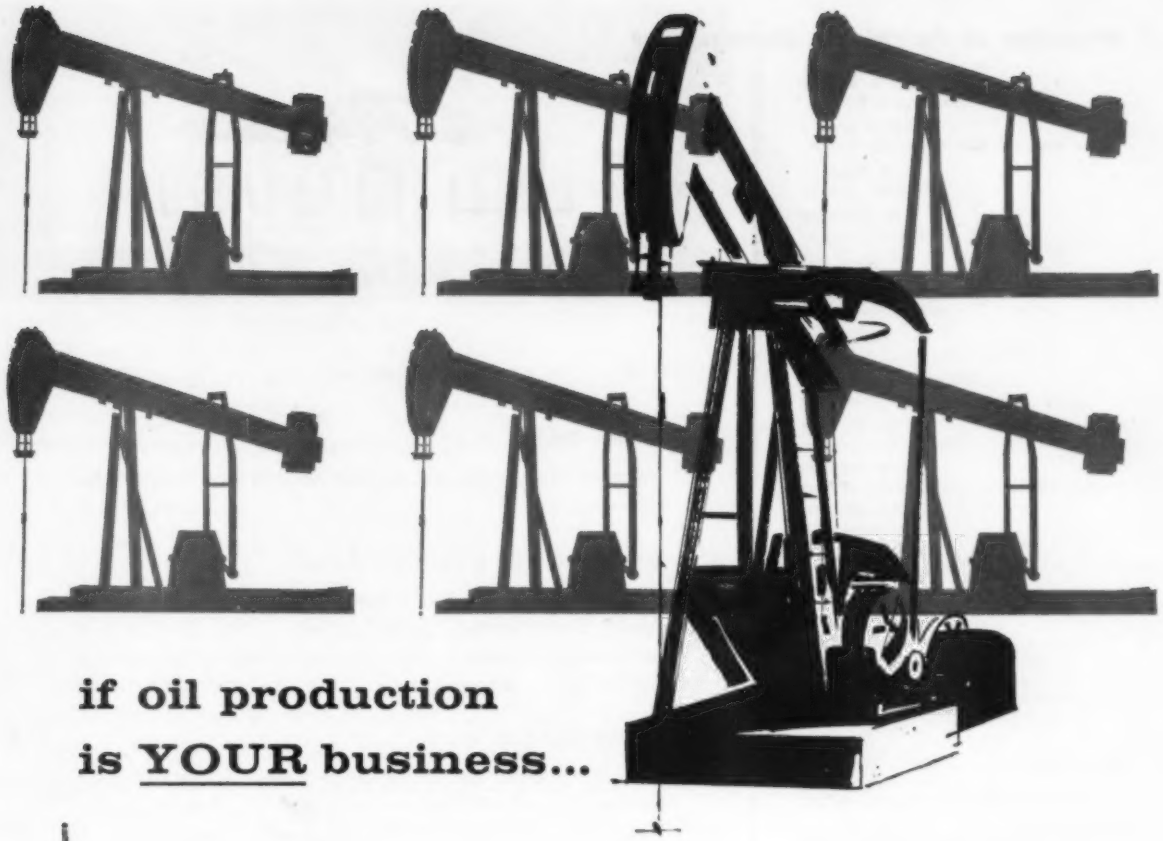

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the Petroleum Engineer

FOR MANAGEMENT

NUMBER 12 • VOLUME XXX • NOVEMBER, 1958

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You might as well fall flat on your face as lean over too far backward. — *James Thurber*

Can Oil Industry Be a Political Force? A-19

A usually silent group is beginning to raise its voice in protest against overwhelming "liberal" power . . . Gulf Oil is first of petroleum companies to announce its intention of launching a political action program. — *Ernestine Adams*

Only the Skilled Can Work A-25

There is no place for an untrained person in the petroleum industry. One of API's big contributions is its extensive organization for training . . . Distribution of knowledge might be called the Institute's most important product.

Let's Take a Look at API Public Affairs A-28

This round table talk brings together the opinions and ideas of men who headed OIC activities during its organization. They and API President Porter and CPA Chairman King discuss the industry's public relations — past and future.

How To Accomplish More with Less Work A-33

Successful, busy executives in the petroleum industry follow this formula to keep work up-to-date with less effort. — *Jack E. Bedford*

Industry Says Get Along with People A-34

— *Ken Hand*

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Although Italian production is increasing (mostly in Sicily where private companies are allowed concessions) great demand of refineries is met most efficiently by Mideast crude . . . The country would be struck a hard economic blow if political troubles limited exports from Middle East area . . . Simplest solution for government would be to follow Sicily's oil laws, opening concessions to outside capital. — *Dr. E. G. Nottes*

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Political Rebels Are Rising

Signs are appearing here and there that entrenched liberal political powers will have a little more opposition in the future. During the last 25 years business and industry has been practically knocked out of politics. No organization gained enough strength to take on left-wing labor union leaders, Republican-Democrat Senator Morris, and anti-business columnists — a slew of riders on white horses dedicated to government-controlled enterprise.

Private business and industry took such a drubbing politically that they have been living on the brink of extinction. Federal indictments fluttered down like ticker tape to attract the mob. A whole industry is punished because invitations to a political dinner said the guest of honor was in favor of *one piece of good business legislation.* Yet Hoffa defies Congress, and the Supreme Court makes it virtually impossible to oust a Communist. The national debt works out to $5165 per family, yet every medicant, domestic and foreign, gets a handout, while the deficit soars and inflation chews on the dollar.

In spite of these signs of political entrenchment of the left in 1958, it has been in this same year that business began its greatest effort to fight back. Industry leaders, alarmed by labor's growing power, sounded a rallying cry. The nation should not be taken by socialists without a struggle.

Two publications became the "Uncle Tom's Cabin" of the scattered free economy forces. First was Donald R. Richberg's "Labor Union Monopoly." Usually on the side of unionism Richberg feels that union members are endangered as much as the general public by the American labor movement today. He warned "Labor's economic monopoly and political power are preparing the way for Communism far more effectively than the Communists themselves."

Another awakening piece of literature was the letter of Congressman Ralph W. Gwinn to one of his constituents.

"You should know," he said, "that labor, or rather the top officials of organized labor, dominate Congress. Over 175 members of the House have benefited from union contributions, free campaign help, radio, TV time, advertising, publicity in the labor press, etc. Business organizations do none of this. Business, as such, is unorganized politically and, therefore, impotent." Then he asked, "If the businessmen of America won't see to it that men are elected committed to restoring constitutional government and law and order in labor-management relations, who else will?"

Gwinn's now famous letter startled the business world. It doubtless had something to do with Gulf Oil Company's recent declaration of political activity. Gulf is one of several petroleum concerns who have affirmed that political freedom belongs to those who use it.

Last year in this same space we wrote an editorial called "Management, Arise, You Have Nothing to Lose But Your Chains!" It looks as if some managements have broken their bonds. May they lead the way to a clearer understanding of economics and politics!

Ernestine Adams

Congrats and $25 to John R. Ewing, P. O. Box 174, Broussard, La.

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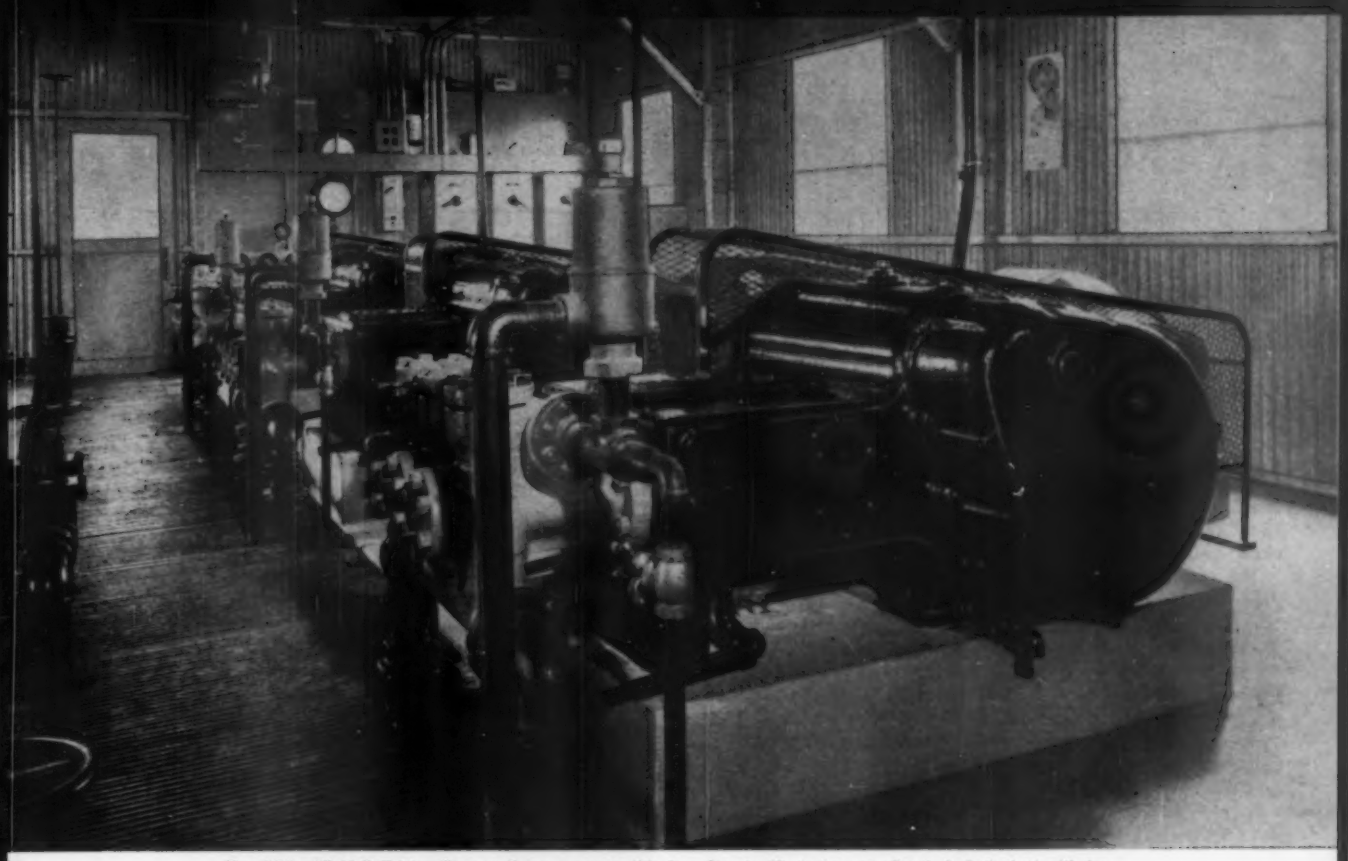

Five "Oilwell" 36-P Triplex Plunger Pumps operate this Lee County, Kentucky, waterflood. A first plant with two pumps was installed some two years ago. The second plant with three pumps (illustrated) was added the following year.

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This installation is typical of the electric-powered "Oilwell" 25L3 Pumping Units which are used to take out the oil.

Petroleum Profile

THE TOP MAN of an integrated oil company has to be an "integrated" oil man. Socony Mobil's chief executive officer —President Albert L. Nickerson—is just that, both by training and inclination.

Mr. Nickerson took over the prime responsibility for running Socony Mobil in February, 1958. Many Mobil men who have known "Nick" for a long time think his training for this top responsibility began back in 1933, when he joined the company.

Tall and soft-spoken, the president has made himself as much at home with a geophysicist as with a refinery manager, and as conversant with the special language of the ocean-going tanker trade as with the jargon of an oil jobber.

His development as an "integrated" oil man had two phases. The first covered the period 1933 to 1944. Graduating from Harvard into a depression job market in 1933, he started out in a company service station in Brookline, Massachusetts, at $19 a week as a pit man. For three years, the service station business was his world. As an attendant, shift manager and station manager he spent many a hard, dirty and cold hour grappling with flat tires and impatient customers. Maybe his start at the bottom of the oil business was the key to his success. "After all," he has said, "there was only one way to go from where I started."

In 1936 his talent for increasing service station business made him a candidate for management development in a new company program. He became a general salesman, and in 1940 won his first management post—district sales manager at Brockton, Massachusetts, not far from his home town of Dedham. He became manager of the whole New England Division in 1941.

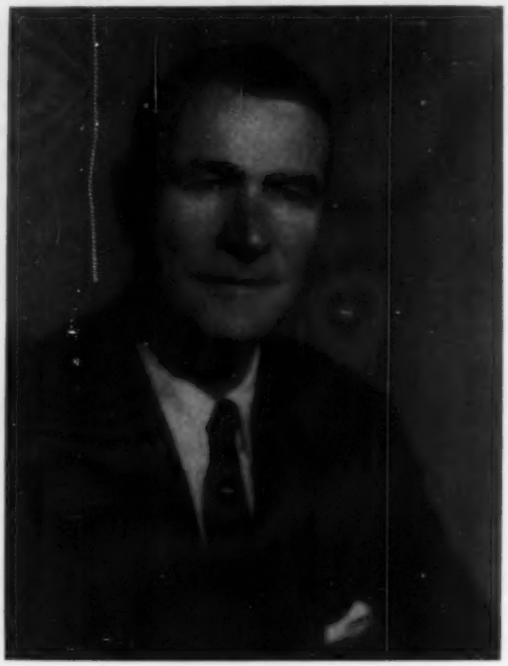
The second phase of his training in "integrated" oilmanship began in 1943 when he was loaned to the War Manpower Commission as Director of the Placement Bureau. Soon after his return to active company service, he became assistant general manager of the 15-state Eastern Marketing Division. Sent to England in 1945 to help rebuild a Mobil affiliate, Vacuum Oil Company, Ltd., Nickerson developed plans which helped the affiliate win back its prewar eminence.

In November 1946, the 36-year-old New Englander returned to New York and was elected to the board of directors of the parent company. He wasn't doing bad—from wiping windshields to top management in 13 years.

Although he was the executive for domestic marketing, his job—like that of every other board member—was to think and act with the whole company in mind. Thus, when the search for crude oil reserves had become an overriding concern for crude-short Socony, he had to persuade the traditionally strong marketing organization to accept the post-war shift in emphasis from marketing to producing without impairing their drive toward progressively higher goals.

The marketing men accepted his leadership—probably because of his outstanding characteristics. First, he appreciates the value of a dollar. He earned his own dollars the hard way (he never earned as much as $5000 a year until 1940) and was, and still is, economy minded. The men who worked with him could follow his example, rather than just his precepts.

(In his personal life the phrase, "It's smart to be thrifty," sums up the Nickerson attitude. The Nickersons and their four children—Christine, Albert W., Elizabeth, and Victoria —live unpretentiously in Rye, New York. Their home life



ALBERT L. NICKERSON
President
Socony Mobil Oil Company

is a reflection of Mr. Nickerson's New England upbringing, which stressed hard work, self-reliance, thrift, honesty—and more hard work.)

But he also believes that company thrift means rewarding the able—the men who hit the ball. With Socony Mobil's biggest capital investment going to crude oil exploration in the post-World War II era, he continued to regard as a basic company policy the development and advancement of marketing men who could produce sales and profits.

In 1951, he expanded his horizons once again when he took charge of the company's foreign marketing and refining as a vice president. Less than four years later he became president of Socony Mobil.

His habitual courtesy and consideration for others make more impression on the public than the aggressive competitive spirit associates claim is the cornerstone of his personality. As one associate says, "He is no man to try to fool. He spots the kernel in the corn faster than anyone I know."

Physical fitness is a preoccupation with Mr. Nickerson. A college oarsman, he has continued rowing as a hobby, and taken up sailing as well. His enthusiasm for the outdoors is contagious—as a young salesman in Massachusetts, he would take his wife Elizabeth down to Cape Cod on a Friday night, and they would weekend in the open with just a pair of sleeping bags.

Mr. Nickerson believes in decentralizing authority and responsibility in a big organization. He wants each manager to be a "respected and responsible executive, running his operation exactly as he would if he owned it, reacting to the same incentives, impelled by the same necessities, in possession of the same vital information."

CRADLING IN NEW YORK—Bechtel Corporation uses its MD7 for cradling operations on a steel gas line. The company has used Cat Pipelayers for a long time. They have enough reserve power to keep going under really heavy loads.

PIPELAYING IN CALIFORNIA—The MD7 lowers in a 16-inch steel gas line for Underground Construction Co. & Stolte Inc. "Cat-built Pipelayers are reliable and the 24-hour parts service we get is a big boon for us," says Project Engineer R. E. Hall.

DRILLING IN ARIZONA—Here Cape Construction Co. uses its MD7 for a drilling operation on a 24-inch crude oil line, running from Four Corners to Los Angeles. In rough going, pipe is being put in the ground at a rate of 2 miles a day. "We rely on Cat-built Pipelayers to get the job done," says Garland Mims, spread superintendent.

Wherever the pipe takes you, the MD7 is ready for action

The Caterpillar MD7 Pipelayer is an all-around machine that comes to *work*—and the harder the work the better.

This big yellow unit is used for unloading and stringing, pipelaying, cradling and—equipped with a bulldozer—can even help backfill. But just as important as the many jobs it can do is the deft, dependable way it handles them.

The MD7, with 128 HP at the flywheel, has a 54,200-pound lifting capacity. And it was engineered to take full advantage of its power. For instance, hydraulically actuated counterweights are available to quickly adjust the lifting capacity to job needs. And no matter how rough the going, seven-roller track frames and 22-inch track shoes can give the machine excellent stability and flotation. No matter how low the temperature, the MD7 will be ready to work when you are because of its positive, dependable starting. Its powerful diesel engine is pre-conditioned by a Caterpillar gasoline starting engine.

For precision work, hydraulic steering boosters give you the accuracy and dependability of manual control without the hard work.

These features have been engineered into the MD7 to help you cut costs. So see your Caterpillar Dealer for complete details. The quicker you see him, the sooner you will start saving money.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

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STANDARD OF THE PIPELINE INDUSTRY

THE CONFERENCE TABLE

You might as well fall flat on your face as lean over too far backward . . . JAMES THURBER

Striking Engineers

The recent strike of engineers and scientists employed in the Research and Development of RCA's Camden, New Jersey, operations is further confirmation of NSPE's long-held viewpoint that professionalism and unionism are incompatible, according to a statement issued by Clark A. Dunn, president of the National Society of Professional Engineers.

In response to requests for Society comment upon the strike which was conducted by the Association of Professional Engineering Personnel (ESA), representing approximately 1800 engineers and scientists, Dunn said that wherever unionism has spread to engineers it has been followed by strikes, picket lines and other usual union tactics.

"It has long been obvious that if engineers want unions they must accept the consequences," Dunn said. "It is foolhardy to pretend that the concepts of professionalism can survive or flourish in an atmosphere of collective bargaining. This latest strike is nothing new in proof of our comment. It was the sixth strike by an engineers' union in the past five years."

The NSPE spokesman added that professional engineers must realize they "cannot have their cake and eat it too."

★ *Failure is the path of least persistence.*

Housing for Laboratories

One of the most interesting things about the "Buildings for Research" (published by F. W. Dodge Corporation, price $9.50), is that it is so full of illustrations of oil company laboratories. The first six pictures of new laboratories in the volume include those of Sinclair Refining, Standard Oil Company (Indiana), Esso Standard at Baton Rouge, and Esso Research at Linden, New Jersey. The 224 large-size pages contain selections of new research buildings and studies on special requirements of good laboratory design. Illustrations number over 500 photographs, plans, drawings, and charts and tables.

As the foreword says, "Research laboratories are rapidly becoming one of the most significant building types of our time." Most of these have been constructed since World War II, and there was a lot to learn quickly about the most efficient types of these self-sustaining units. For those companies whose research centers are being expanded or who are contemplating new laboratories, this volume is essential reading.

What's the CPA?

The initials CPA have a new meaning, and it's not Certified Public Accountant. The new Committee on Public Affairs, which combines the APIC and OIC in the American Pertoleum Institute, is already being called CPA.

One of the most interesting discussions we've had anything to do with is the article on round table opinions from former chairmen of the OIC and from President of API, Frank M. Porter, and Kerryn King, chairman of the Committee on Public Affairs.

We think that the right approach to CPA will play a vital part in the future of the industry. You'll understand the situation better after reading "Let's Take a Look at API's Public Affairs," on page A-28.

Government Called Capricious

We're rather slow commenting on a letter signed by President W. K. Whiteford, of Gulf Oil Company, concerning the antitrust law applications of the Federal Government. The letter, published in the company magazine, *The Orange Disc*, was blunt and to the point.

Gulf's management maintained the Federal Government has "no unified, clearly understood policy as to where, when, or under what circumstances the antitrust laws shall be invoked."

The company pointed out it had no quarrel with the actual laws themselves as they apply to the domestic industry of the United States. It said "To the extent that our antitrust laws have helped to create and maintain this competitive climate, their equable enforcement is as beneficial as any service our government could perform."

Its biggest quarrel, the Whiteford letter said, was with the government's steadily enlarging tendency toward inconsistency, contradictions and caprice. It often appears, read the statement, that one arm of the executive branch does not seem to be aware of what another arm is doing in respect to handling antitrust administrative matters. The letter went thoroughly into the indictment by a Federal Grand Jury at Alexandria of 29 oil companies, including Gulf.

This letter preceded the famous letter of Gulf Vice President Gray in the succeeding issue of *The Orange Disc*, in which he stated the determination of Gulf to plan for political action (see Page A-19).

Only the Skilled

The way the training program of American Petroleum Institute is enmeshed in the petroleum industry is described in the story "Only the Skilled Can Work," Page A-25. The oil industry needs many trained people, and even those who are skilled need further training to keep up with technological progress and with new types of operations.

It's a thrilling story—almost a Horatio Alger story—but it's hard to put into words. The training program is one department in which the oil and gas industry can take great pride. We can't give enough credit to the men who developed these courses and organized the material so that men can learn easily and quickly.

Those American Gadgets

We have a lot of intriguing equipment in our various laboratories, but none, perhaps, stirred up as much interest among visiting firemen as did an instrument in the Cincinnati lab of American Bitumuls & Asphalt Company. With Abaco's Dan Fink as guide, two overseas visitors from Belgian-Petrofina were touring the laboratory one day this spring. They seemed quite familiar with lab operations, but were stopped cold by the aforementioned instrument which was fastened to the end of a work bench.

Dan says their interest was astounding. The emissaries asked him to run the thing through its complete operation several times and excitedly took notes as he did so. They made sketches, copied the manufacturer's name, and jotted down the serial number.

The instrument? A can opener.

—From *The Standard Oiler*

Leadership Needs Research

Leadership in industry "can be achieved only by introducing innovation" and innovation is dependent upon the carrying on of research, American Institute of Electrical Engineers were told at a meeting in California.

Presenting a paper at a session on management and research, Thomas M. Linville, operations manager at the General Electric Company, said: "Markets will control wages and prices to such an extent that the greatest leverage lies in leadership. This may be introduced in any or all functions of the business, but it is especially powerful when directed to product leadership. Here research is a tremendous asset. The sequel to research is invention, and the sequel to invention is opportunity for leadership and better profits. For those who aspire to leadership, then, research belongs in industry."

He defined the functions of industrial research as determining of key areas of science to unlock new business opportunities, analysis of scientific progress and likelihood of breakthroughs in key areas, accomplishment of research in key areas and feeding of new knowledge and invention to business operations.

"Research is a function distinguishable and apart from engineering although complimentary to it," he said. "Furthermore, (the studies) give evidence that research is gaining appreciation as an operation in itself and that evaluation and management of the work is rapidly progressing, including the associated functions involved in the laboratories wherein the work is done."

★ *When a man says money can do everything, that settles it; he hasn't any.* —Edgar W. Howe

Oil Firms Take on Nuclear Business

Petroleum companies are buying into nucleonics at an ever increasing rate. Today, when you buy nuclear fuel stock, chances are good you're also buying oil stock. Vice versa is true as well.

These are the startling financial facts uncovered in a recent survey by *Nuclear Review*, a journal covering the nuclear industry.

Of top two dozen uranium mills, four are oil-firm owned, in whole or in part. Eight of 32 companies with big radiation research laboratories are petroleum firms. Of more than 1700 users of radioisotopes, valuable by-products of atomic fission, some 75 are oil companies.

The Texas Company has just opened a research center in Beacon, New York, that is the world's most fully equipped private radiation laboratory. Its 29,100 curies of radioactive cobalt-60 is one of the most powerful sources of radioactive material outside the United States Atomic Energy Commission.

Phillips Petroleum Company is a major oil producer and refiner. Recently, it blossomed into a major miner and miller of uranium. Its brand new $10-million refinery can process 1700 tons of ore daily. Two rich uranium mines in the prominent Ambrosia Lake area of New Mexico belong to Phillips. The magazine estimates Phillips has some 5-million tons of atomic fuel ore.

Some refiners, like Esso Standard, restrict nuclear investments to radioisotopes. Others scramble to build atomic-powered tanker ships, start mining or milling ore, or to enter reactor research. Kerr-McGee Oil Industries, Inc., Oklahoma City, prefers the back door. It owns 51 percent of Kermac Fuels Corporation. Kermac has four uranium mines and a huge 1500 ton a day mill.

Superior Oil Company of California now mines uranium in McKinley, New Mexico. San Jacinto Petroleum Corporation is joining forces with U. S. Homesake Mining and other firms to assure uranium for its 750-ton daily output mill.

In 1957, nine oil companies became users of radioisotopes. Oil well drillers, transporters, and refiners use these radioactive materials for testing and inspection, studies of effects on oils, detection of leaks, measuring fluid flow, studies of catalysts.

Running radiation laboratories are Continental Oil, Esso Research & Engineering, Sinclair Refining, Cities Service, Gulf Oil, Socony Mobil and Texaco.

Most used forms of radioisotopes are two: Fixed sources and tracers. The latter consists of radioactive materials injected directly into process streams. A little radioactive material added to any fluid makes it easy to follow with a sensitive detection instrument.

Fixed sources seem to be finding more uses, the survey shows. These isotopes are usually inside a thick lead box, with a camera-like shutter door. They can shoot a weak beam across the top of a tank of liquid to a detector. When the tank fills up, it cuts off some radiation; then the detector automatically stops the flow. Thus, the tank can never overflow. The same idea works in inspecting pipelines, or controlling the thickness in fabricating industries.

These sources also can make radiographs, much like conventional X-ray photographs. Oil companies use this extensively to radiograph vessels, pipes, tubing, and welded joints. Users can tell the exact thickness of a tank wall with radioisotopes or they can tell if there is fluid inside.

However, strong radiation can alter petroleum product properties, even cause irrepairable damage. Surprisingly, there have been no major accidents involving oil company use of radioisotopes, the survey finds. Though potentially dangerous, petroleum firms guard against such accidents with safety precautions which are the envy of organizations in other fields.

Companies are not just trying to use nuclear energy to make their near-future oil and gas business better. "We are also looking forward," says Texaco "not only to this better utilization of our world petroleum resources, but to the inevitable harnessing for everyday use of that other and inexhaustible energy source—the atom itself."

★ *Everything is funny as long as it is happening to somebody else.* —Will Rogers

Legal Literature

The Sixth Annual "Institute on Mineral Law" has published a collection of papers presented at the 1958 meeting at Louisiana State University Law School. The Institute is now an established program of the state university. We were attracted by such chapters as "The Functions of a Geologist as Consultant to a Landowner" by Gordon I. Atwater, New Orleans consultant. There is no doubt that the papers merit careful attention of those members of the bar interested in oil and gas law. Cases decided in Louisiana during 1957 are reviewed.

Edited by two members of the legal faculty of Louisiana State University, it was published by University Press, Baton Rouge, Louisiana. The volume sells for $7.50.

Please turn to Page A-35

HIGHLIGHTS

★ ★ ★

Digest of News and Comment

Arkansas Fuel May Divide

Cities Service Company has submitted a plan to the SEC for the division of Arkansas Fuel Oil Corporation into two separate companies. Cities Service, who owns majority interest in Arkansas Fuel Oil, has been ordered by the SEC to either dispose of its majority interest or to eliminate the minority interest. The plan would set up two companies, each a complete operating entity, with one owned by Cities Service and the other company to be owned by minority shareholders. Cities Service has held majority interest in Arkansas Fuel since 1928.

Kansans Fete Petrofina

Citizens of El Dorado, Kansas, honored a new citizen, American Petrofina, Inc., with a day-long celebration marked with a western-style dinner and addresses by local dignitaries, oilmen, state congressmen and Kansas Governor George Docking. Petrofina's president, Harry A. Jackson, took part in the celebration. The newly-integrated company entered El Dorado with the recent acquisition of Petro-Atlas Corporation and its wholly owned subsidiary, El Dorado Refining Company. Petrofina has producing properties, pipeline facilities, and marketing outlets in several Mid-Continent states and two other refineries in Texas.

Demand Estimate Revised Upward

Bureau of Mines has adjusted its 1958 estimate of domestic demand for refined products upward, predicting an increase of 2.1 percent over last year. Domestic products demand is expected to be 8,990,000 bbl per day. Crude production for 1958, the Bureau estimates, will be about 6.3 percent below 1957, averaging 6,717,000 bbl per day.

Brown Retires from IPAA

Russell B. Brown has announced his retirement as president of the Independent Petroleum Association of America, culminating 30 years of service to domestic oil and gas industry in Washington. He first accepted presidency of the IPAA in 1929 on a "temporary basis." "Mr. IPAA" will continue his active duties as general counsel for the next year, entering full retirement on December 31, 1959.

Murphy Gains Marketing Interest

Stockholders of Hempstead Oil & Storage Company, Inc., of Mobile, Alabama, and the Murphy Corporation, El Dorado, Arkansas, have reached an agreement whereby Murphy will acquire a substantial interest in Hempstead, a gasoline and products wholesale marketer for 30 years in the Southeast. Murphy, primarily a producer, operates in Gulf Coast states, and through its River States Oil Company subsidiary, markets refined products in Iowa, Illinois, Wisconsin, and Minnesota. Earlier this year Murphy acquired the Lake Superior Refinery at Superior, Wisconsin.

Gas Cited for Fuel Oil Drop

Increasing volume of natural gas into the West Coast states has been given as the principal reason for recent downward revisions in buying and selling prices for heavy crude oil and fuel oil in California. Standard Oil of California announced it dropped its selling price on fuel oil 35 cents a bbl to the 1956 level. At the same time it announced reductions for paying prices for heavy crude oils, from 50 cents for 14 deg to no change for 27 deg gravity oil. The company points out that "The West Coast oil industry now has approximately 34,000,000 bbl of fuel oil in storage, an increase of nearly 13,000,000 bbl over a year ago. The natural gas imported into the five western states in 1958 is displacing the petroleum equivalent to approximately 450,000 bbl daily; as recently as 1947, this displacement was only 15,000 bbl daily."

Foreign Oil Investments Increase

A major portion of private U. S. investments abroad are going into oil exploration and development, reports the U. S. Department of Commerce. Of the total $4 billion spent abroad by private organizations and individuals, about $1.7 billion was used to obtain new concessions, develop existing oil production and build refining and distribution facilities. Of the total $37 billion investment by private U. S. investors on record at the end of 1957, foreign petroleum investment amounted to approximately $9 billion. More than $3.2 billion of the total has been expended in Latin America.

Texas Counts "Readjustment" Costs

"Texas oil and gas producers hope that 1958 will go into the record books as a breather for readjustment and not as a signal for a long-term decline," says Charles W. Alcorn, president of the Texas Mid-Continent Oil & Gas Association. Alcorn predicts a generally high level of business activity with resulting increased oil production and demand, but expresses concern over development of future reserves. Looking at 1958, the association estimated the total value of sales of oil and gas from Texas wells would be about $3.35 billion, some 14 percent under 1957. Also, royalty owners would see their checks drop by $78,000,000 from the record high of $580,000,000 in 1957. Employment in drilling production phases in mid-1958 was off some 12,600 from that of 1957; drilling was off 20 percent; state tax revenues from crude production were down $22,000,000 from fiscal 1957; refineries were operating about 10 percent below the previous year.

Imports Plan Action Asked

Sunray Mid-Continent Oil Company President W. C. Whaley has asked M. V. Carson, administrator of the imports program, that the new imports plan be put into motion soon. Whaley defended the revised program and suggests that the formula which measures the importers' allocations for the second half of 1959, be changed from the period ending March 31, 1959, to the period ending December 31, 1958. This change, according to Whaley, would minimize the opportunity for anyone to take advantage by individually increasing crude runs in an excessive amount. The president of the Tulsa based company likened the new imports program to sound production and allowable rules existing under state regulatory body leadership.

TBA: Big Business

Tires, batteries and basic auto accessories (TBA), will amount to a $1.4 billion business for service stations this year, predicts the United States Rubber Company. Just 10 years ago, service station TBA business amounted to less than half that figure. Today, service stations sell one-third of all replacement passenger tires sold in the U. S., 38 percent of all replacement batteries for passenger cars and 68 percent of all anti-freeze purchased by motorists. The rubber company pointed out that the average service station will sell 200,000 gal of gasoline; 2800 hours of lubrication and servicing, and $7718 worth of TBA products.

OPERATION PROVES
It's Cleaner Gas with
PEERLESS
SCRUBOSPHERES

Operation of these four 66" I.D. Scrubospheres has demonstrated their superiority over conventional oil bath dust scrubbers. The dust removal ability of the SCRUBOSHERE is outstanding because it utilizes wetted surfaces for dust collection which are more closely spaced than in conventional equipment.

Operation of these Peerless units has also proven their superiority with respect to minimum oil loss, because oil is periodically removed from the Scrubospheres whereas **it must be periodically added to other scrubbers** in the same plant operating under comparable conditions. Patent applied for.

Let your Peerless Representative give you full details.

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

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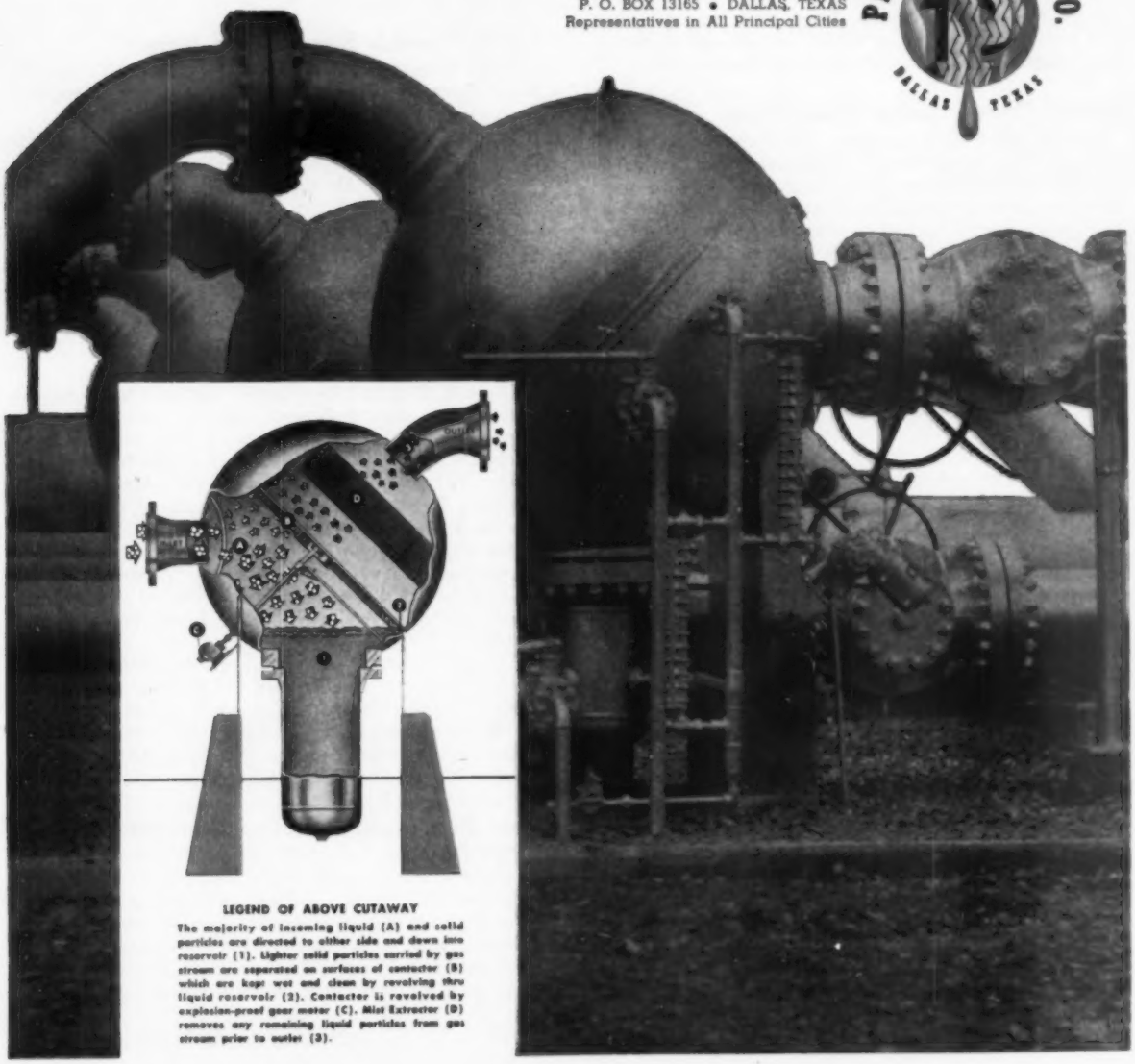

LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

Import Suggestion Summary Due

Captain M. V. Carson, administrator of the government's voluntary import program, has been summarizing 169 statements from oil companies and interested groups concerned with the proposed refinery-run based import plan. Carson will present the comments to President Eisenhower and to Secretary of Commerce Sinclair Weeks. The cabinet Committee, headed by Weeks, would then study the suggestions, disagreements and general comments in November. Carson does not plan to make individual statements public, although his summary to the President will be released.

6000 Expected at API Meeting

More than 6000 oilmen are expected to attend the 38th annual meeting of the American Petroleum Institute which convenes November 10 in Chicago, Illinois. The meeting will be one day shorter than usual, and sessions will be streamlined to cover the large scope and content being presented. More than 130 committee and sub-committee sessions are on the program—some beginning as early as November 6 and others scheduled as late as November 13.

Conrad Hilton Hotel will be principal headquarters for the meeting and all sessions except those of the division of transportation and marketing. Transportation headquarters and sessions will be in the Palmer House, and marketing headquarters and sessions will be in the Congress Hotel.

Goliad Opens Pembina Gas Plant

Goliad Oil & Gas Company has placed in operation Canada's largest natural gas liquid extraction plant. The $21,000,000 installation obtains casinghead gas from some 290 tank batteries owned by 71 operators in the Pembina field in Alberta. The plant, constructed and put on stream in less than 15 months from the presentation of first proposal, serves eight of the nine gas conservation units, and 88 percent of the operators in more than 250,000 acres of the total Pembina producing area.

The facilities are designed to conserve about 85,000,000 cu ft of gas per day, manufacturing about 65,000,000 cu ft per day of residue gas for utility distribution and recovering 196,000 gal of propane, butane, pentanes and isopentanes. Construction of approximately 350 miles of gathering lines and 22,000 hp of gas compressors were included in the project, states Harry W. Bass Sr., board chairman of Goliad.

Richfield Proposes Atomic Tar Blast

Richfield Oil Corporation has submitted plans to the Canadian government for exploding a nuclear device underground in an effort to free fluid trapped in the Athabasca Tar Sands in Northern Alberta. Richfield has oil rights to 50,000 acres in the area. Engineers believe that the heat and kinetic energy from a controlled atomic blast would make the oil flow freely, allowing oil to be pumped from the sand. The project, if successful, would open the largest known oil reservoir in America. The plan is to be discussed in Canadian cabinet meetings in the next few weeks, but may require as much as two years of technical study before preparations could be made for such a blast.

New Pan Am-Arab Deals Talked, Closed

Pan American International Oil Company negotiations involving oil concessions in the preferential rights area in Saudi Arabia were turned down by the parent company, Standard Oil Company of Indiana. The agreement under discussion would not be on the 50-50 profit sharing basis used in the past, but would give the Arabian government a larger share of both operations and profit through participation in an integrated company. The new agreement would involve blocks totaling 10,000 square miles in the central part of the desert country. Since this involves the preferential zone, the deal must be first offered to Arabian American Oil Company.

The 50-50 profit split plan has already been broken by the Japanese in a 56-44 split with Arabia on the Arabian peninsula and with at 57-43 deal with Kuwait. Pan Am has broken the basis with a 75-25 profit split in Iran.

Nuclear Ban Exemptions Asked

The Atomic Energy Commission is exerting pressure to exempt industrial explosions from any nuclear ban that might be arranged at the Geneva Conference in November. More than a dozen companies have been negotiating for use of such tests since the AEC released a favorable report on pulverization power of an underground atomic bomb test last September. Power, mining, and oil companies are listed as being interested in the industrial potential. Oil might be "freed" from shale oil zones, tar sands and depleted reservoirs through nuclear blasts, the AEC relates.

Signal-Hancock Merger Vote Near

Signal Oil and Gas Company and Hancock Oil Company stockholders will vote on the proposed merger of the two firms on December 4.

Hancock stockholders are scheduled to meet on that date in Long Beach and Signal stockholders meet on the same day in Los Angeles. The directors of both companies voted unanimously for the merger, to be on a share-for-share basis, on September 12. Samuel B. Mosher will remain board chairman and chief executive officer, and Russell H. Green will continue as president. Present directors of both companies will be named to the board of the merged company. John W. Hancock is president of Hancock.

ASME Names New Officers

Glenn B. Warren, vice president and consulting engineer of the turbine division, General Electric Company, has been elected president of The American Society of Mechanical Engineers. Elected to serve with Warren were five vice presidents: Charles H. Coogan Jr., head of the Mechanical Engineering Department of the University of Connecticut; Gordon R. Hahn, assistant chief mechanical engineer for Gibbs and Hill; John W. Little, president of the Goslin-Birmingham Manufacturing Company; Thomas J. Dolan, head of the Department of Theoretical and Applied Mechanics at the University of Illinois; Harold Grasse, partner in Black and Veatch.

In addition, Arthur M. Perrin, president of National Conveyors Company, and Richard G. Folsom, president of Rensselaer Polytechnic Institute, were elected directors of the 50,000-member Society. All the electees will take office at the business meeting on the first day of ASME's annual meeting in New York, December 1-5.

New Gulf Crude-Handling Department

Gulf Oil Corporation has announced its new Crude Oil department, which was formed in September is now responsible for all sales, purchases, and exchanges of crude oil in the world-wide operations of the company. Jurisdiction for domestic crude oil transactions has been transferred from R. P. Huggins, vice president, to W. H. Blackledge, manager, crude oil department, Western Hemisphere.

Good Wells Make Good News

A Monthly Report of Successful Well Treatments

November, 1958

Fracturing with acid-base fluids and sand often gives better results and a quicker payout than either acidizing or fracturing alone. Here are some recent successful results:

- **Colorado County, Texas Gulf Coast.** (Old Gas Well) This well—completed through four sets of perforations into the Wilcox (8596 to 9127 feet)—had been dead four months. Dowell fractured with Acid Petrofrac*, using 16,000 gallons acid-oil emulsion and 16,000 pounds sand. Injection was down 2½-inch tubing at 5 bpm; pressure reached 5700 psi. 45 days after treatment, well was delivering 750 mcfd into 800 psi gathering line. Distillate recovery was 30 bpd. *Dowell treatment paid out in less than two months; total workover cost paid out in less than three months.*

- **Ector County, West Texas.** (New Oil Well) This well was completed in the sandy lime of the Tubbs formation. Solubility was about 85 per cent and salt content was about 0.35 pounds per cubic foot. Two sets of perforations (2 shots per foot) were made between 6168 and 6480 feet. No test was made before treatment because wells in this field require stimulation. Operator ordered Duofrac*. Dowell used 500 gallons Mud Acid to spearhead, followed by 25,000 gallons 7½ per cent acid with demulsifying agent and 25,000 pounds sand. 472 perforation ball sealers were injected in four stages of 118 each (after each 5000 gallons). Injection averaged 49 bpm at 2300 psi maximum. *Well is producing top allowable of 111 bopd.*

- **Cowley County, Kansas.** (New Oil Well) This well was completed in a cherty lime of 30 to 36 per cent solubility. Completion was through 10 feet of perforations and five feet of open hole. Total depth was 3031 feet. The operator ordered Acid Petrofrac. After cleaning up the well with 500 gallons of Mud Acid, Dowell fractured with 15,000 gallons acid-oil emulsion with FLA* (Fluid Loss Additive), and 15,000 pounds sand. Injection was down 4½-inch casing at 1650 psi and 27½ bpm. *Before treatment, production was ½ boph. After fracturing, the well swabbed 11 boph. State potential was 90 bopd with 5 per cent water.*

- **Burke County, North Dakota.** (New Oil Well) This well was completed in the Nesson lime through an 11-foot perforated section at about 6000 feet. Before treatment, well tested only a show of oil. After treatment with 250 gallons BDA* (Breakdown Acid), well swabbed one boph. Well was then fractured with Acid Petrofrac. Dowell injected 2000 gallons acid-oil emulsion with FLA (Fluid Loss Additive) and 1750 pounds sand. Injection rate was five bpm at a maximum pressure of 5800 psi. *30 days after treatment well was flowing 90 bopd.*

The selection of the most promising stimulation treatment is often the most important part of a successful job. Take full advantage of Dowell's experience in selecting the treatment best suited to your well. For service or more information, call any of the 165 Dowell service points and offices. In Canada, contact Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Dowell, Tulsa 1, Oklahoma.

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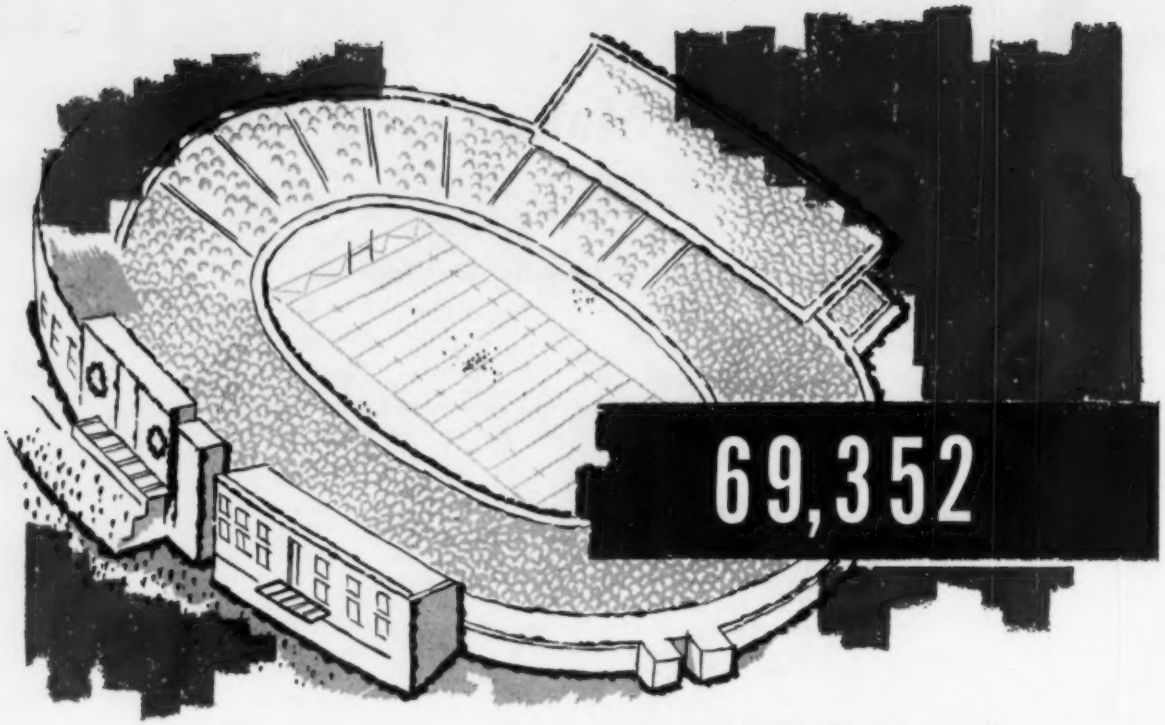

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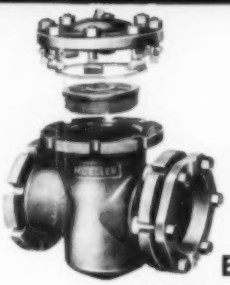

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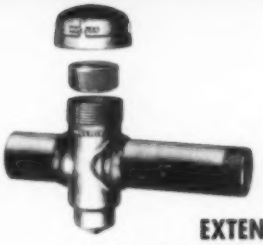

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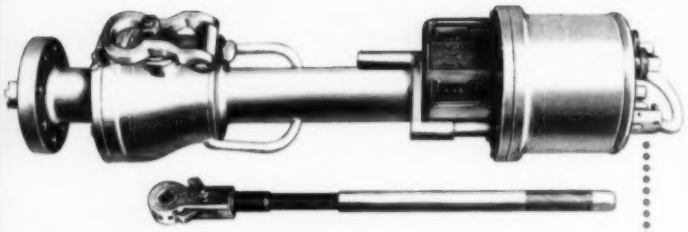

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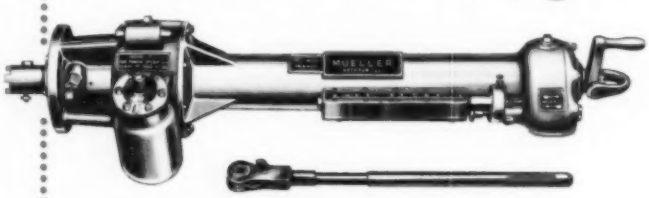

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Can Oil Industry Be A Political Force?

A usually silent group is beginning to raise its voice in protest against overwhelming 'liberal' power . . . Gulf Oil is first of petroleum companies to announce its intention of launching a political action program . . .

Ernestine Adams
Management Editor

MODERN PETROLEUM COMPANIES will tell you almost anything about their business. They give financial statements, engineering reports, publish reserve figures, predict the future, and appraise the past.

But when Gulf Oil Corporation released its political action policy on September 10, 1958, the industry was rather startled by a new level of frankness.

Senior Vice President Archie D. Gray signed the company's statement that declared Gulf's determination to take an increasingly active interest in practical politics, especially in such areas as it can oppose labor's mounting political power.

Union leaders responded with cautious statements. Associated Press reported that James L. McDevitt, director of AFL-CIO Committee on Political Education (COPE), said that Gulf executives were already veterans on politics.

In the Gulf Coast district Elro Brown, of Houston, representative of Oil, Chemical, and Atomic Workers Union said "Gulf is only publicly announcing what it has been doing all along."

He brushed aside any speculation that his union was under Gulf's attack. "Our relations with Gulf are as good as with anyone in the oil industry at the present time" he observed, and went on to say "If the Gulf announcement will stimulate more people to more civic mindfulness the social welfare programs of the unions will be enhanced. We will gain additional support if Gulf gives its employees factual information about voting records."

These rather approving statements by labor were fully backed by Gulf's correspondence. Out of 400 letters, wires, and telephone calls, only three[1] attacked the decision of the company to plan for political action. The Gulf statement made the front pages of many newspapers. It has been the most talked about subject in industry meetings since.

Gray said details of the firm's political program would require long and careful planning and that it was not yet possible to issue a detailed statement of such a program. He went on to say, however, that certain types of activity are indispensable to the success of any program. For one thing, Gulf will encourage its shareholders, employees, and dealers—a total of more than 161,000 individuals—to become more active participants in politics in the area where they live.

Another aspect of the program must consist of a continuous study of the official behavior of elected officials. Initially this will concentrate on the members of the Senate and House of Representatives involving such things as their records of attendance at important sessions, how they voted on significant measures, studies of their speeches and analyses of their official attitudes as revealed by committee activity. It will include everything that may help an individual to determine whether his Senators and his Congressmen are serving him well.

Gray went on to say that the years are over when Gulf, as well as most other American corporations, can afford to become so busily engaged in business activities that politics are ignored. "Whether we want to be there or not" he stated "Gulf and every other American corporation is up to its ears in politics and we must either start swimming or drown. Gulf's management would be derelict in its duty to its shareholders and employees alike if it tried to ignore this fact and did nothing."

Although the letter was on the positive side, using union political activity as an example of what business should do, it was natural that newspaper reports stressed the management vs labor phase. The letter, itself, did not appear to be anti-union so much as a plug for better business legislation.

Mr. Gray said "Perhaps a good way to get started would be for each person who receives this issue of *The Orange Disc*[2] to send a letter to the Senate and House candidates for both parties in his area, requesting the favor of their comment."

He added "The fact that organized labor has been following a similar line of action is the reason that labor leaders

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EDITOR'S NOTE: In selecting this title we are fully aware of the vociferous anti-petroleum voices that loudly declare that the 'oil lobby' and 'gas lobby' have Washington in chains. These facile writers in The New York Post, The New Republic, in syndicated columns (Thomas L. Stokes, Drew Pearson, et al) have never explained why the industry, with this all-powerful lobby, continues to draw more taxes (than any other industry) and more regulations (for instance, via court decisions as in the natural gas decision). Congressman Harris, who has some understanding of petroleum industry operations, is appalled at the so-called 'lobby's' ineffectualness (See "Only the Petroleum Industry Can Act," The Petroleum Engineer, October, 1958, page E-17.) Truth is, the proponents of state enterprise are fighting a paper mache Goliath when they fight the 'oil lobby' or the 'gas lobby.' It makes a pretty spectacle for the public and there is no danger. The pseudo-Davids take turns propping up the phantom giant.

[1]Also three anonymous messages.

[2]Company magazine of Gulf Oil Company in which letter appeared.

Practical political seminars for executives are already organized

have achieved dominance over our national legislative assembly. If our free competitive institutions are to be preserved from destruction by the unholy combination of predatory gangsterism and crackpot socialism that is thriving and expanding under labor's Congressional benevolence, then business has no choice. It must do likewise, or throw in the towel."

Should Bosses Organize?

Political history in the last 25 years has been marked not so much by party issues as by the growing power of the left-wing socialist groups, typified by several battling union leaders. This trend has been accompanied by virtual collapse of business leadership in politics.

Management was intimidated by state laws and the Federal Corrupt Practices Act, which makes it a criminal offense for a corporation to spend money to support specific candidates for federal office in election campaigns.

Then not long ago labor unions carved out a way for political activity. United Auto Workers used union funds to sponsor T-V programs about political candidates. Democratic party people were featured. The court's decision considered this an educational program and UAW was found not guilty of violating the Corrupt Practices Act. Could it be that management, too, would be permitted to speak?

Some brave corporations like General Electric, U. S. Steel, and General Dynamics began seminars for their executives on practical politics. General Electric also established a government relations service to help its management personnel develop a better understanding of the inter-relationship between government and business.

One set of papers that we have looked over is material used in the Syracuse Political Seminar, sponsored by the Manufacturers' Association. This project developed because of a study that showed that the major obstacle to better climate for business in the area was increasing government-imposed costs.

In one of the lectures these cards are used to show four factors that constitute a threat to our competitive enterprise system.

1. Increasing impact of government on business operations. Every major issue today has a direct bearing on operation of business and industry. For example, one decision of the National Labor Relations Board can undo years of collective bargaining with the union.

2. Increasing government-imposed costs of doing business. Rising legislative costs of business, especially in the tax area, are whittling away managerial control over important factors in the operating statement. Today with government costs mounting at every level the easiest place to look for increased revenue is business—the politicians favorite "whipping boy."

3. Ineffectiveness of business in politics. This is brought on partially by businessmen themselves. It concerns the apparent inability of business to sell its economic and political ideas. It has led politicians to the conclusion that votes can be gained by attacking business. The current anti-monopoly investigations in Washington are a good example.

4. Labor leaders goal of government domination. A massive drive by union leaders to dominate government at all levels. Said George Meany, AFL-CIO president, "The scene of battle is no longer the company plant and the picket line. It has moved into the legislative halls of Congress and the State Legislatures."

Money donations are not enough, say the men who conduct these seminars. The Practical Politics laboratory work consists of outside assignments for participants. These include:

1. Writing a personal letter to a congressman.
2. Visiting a local council meeting.
3. Contacting a state legislator.
4. Visiting an election district committeeman in the neighborhood.
5. Breaking down and appraising local tax rates.
6. Ringing 20 doorbells and finding out if the occupants are registered to vote.

What Oil Companies Say

Reaction of petroleum companies to the Gulf stand went all the way from disapproval to considerable enthusiasm. It was learned that a number of companies already have programs that resembled a formal policy although they may not be called that. One executive said "I do not believe our people need any practical politics seminars. We have never been afraid of engaging in political activities."

Although Standard Oil (Indiana) has not made a formal release on its political policy, it has repeatedly taken the stand that politics affect business and that therefore business must be concerned with politics. "This is a way of life in our company well understood by management people and others," a company spokesman stated.

As far back as the API meeting of 1956 Frank O. Prior, then president and now chairman of Standard (Indiana), called for industry political action, saying government can take our business away from us faster than our competitors can. He told oil men flatly that the time had come to "Put up or shut up." He went on to say:

"... in politics, the credit goes to those who convince the public. We have allowed a few loud-mouthed demagogues to assume the credit for too many achievements. Others have been allowed to discredit us without challenge. We must not only tell the truth, we must sell the truth.

"Those of our opponents who favor a socialized and regimented society have worked even harder and done more than we have. Too many times through unchallenged fabrication and distortion, they have confused and bewildered the public and therefore legislators on the basic issues.

"For myself, I do not intend to stand idly by while political charlatans and pressure groups undermine the industry to which my life has been devoted.

"Are we afraid of the word 'lobbying'? I'm not. I don't pretend to know all of the technical interpretations of the law. But I do know how the word is generally used. I also know that the First Amendment to the Constitution spells out our right to petition the legislators and to submit any information which is in the public interest."

Internally Standard's policy has been to encourage employees to participate in local government. Need for time by employee volunteers for such activities as pollwatching have been given ample consideration. Company executives have repeatedly emphasized the need for registration and voting by all eligible, strictly on a non-partisan basis.

The company has publicly complimented employees and dealers who are active in political and civic life through a medium of institutional advertising. This is a series which features people in various communities who work for Standard and also serve in political office. One, for instance, is headed "The Mayor Leads a Double Life."

Standard (Indiana) representatives have made many appearances before governmental bodies from the local to the national level to express company views on pending actions. A recent example was testimony before a congressional hearing to commend the view that action this year to increase social security rates was unwise.

This type of political action is followed by many companies. It has been largely unappreciated by the industry as a whole and by the public because it receives little notice in the press.

Said a Standard (Indiana) spokes-

Study of official behavior is voter's duty in majority opinion

man "The company so far has not thought it necessary to have a detailed statement of policy or an organized effort in the area of promoting employee political participation, but its actions have been consistently in the direction of promoting interest in politics on the part of its employees and good government at every level."

Delhi-Taylor Oil Corporation management was very pleased about the greater interest in political duties of the petroleum industry. The company stated: "Delhi-Taylor has been extremely active in political campaigns both on a local and national level. Although we do not have a planned program of indoctrinating employees and stockholders, we feel that our informal program of inter-office memos, articles in the company newspaper, etc., have been effective in stimulating interest in various political issues and candidates.

"The company's policies on political matters are constantly being revised. However, at this juncture it is the consensus that we will continue to exert only an informal influence."

Tidewater Oil Company was another that answered positively on their feeling about politics. "We have never hesitated to speak out on political issues when it seemed advisable to do so in the interest of employees, shareholders, and the general public," read the Tidewater statement.

"We are inclined to be more rather than less active in the political field. While we have no formalized program, we expect to continue to encourage shareholders and employees to take an active interest in political issues that may affect them."

Asked if the company would study official behavior of elected officials, Tidewater said "While we do not make a practice of commenting on the actions of individual government officials, we do not hesitate to do so should the circumstances require in the interest of fair play that we speak out."

Concerning Union Oil Company of California policy, A. C. Rubel, president, said:

"On issues which we believe will have an effect on the national economy or the business community, we have used the various communications methods at our disposal to advise all of those connected with the company—employees, share owners, dealers and so on — of the pros and cons of such issues.

"We certainly feel that individuals should study the official behavior of elected officials. However, our informational activities have been primarily leveled at the relative merits of various issues. The individual's interest in and understanding of today's political-economic issues are essential; and if we assist in awakening that interest, the official voting records are bound to be closely watched.

"Whether business likes it or not, business is in politics. It is now a question of how successful we will be in the political arena."

Like Mr. Rubel, most of those who discussed the study of official behavior of elected officials, thought this was the individual voter's duty. At the present time officials are graded by Americans for Democratic Action (ADA) and COPE. Their findings are widely publicized. Those of a more conservative blend may use these in a negative way but they have no positive evaluation from an authoritative source.

Approves Rating Officials

Robert E. Kepke, president of The British American Oil Producing Company, made this statement concerning business participation in politics:

"Business is taxed, regulated, restrained and often harassed by government and officials of government. A concerted effort by business to examine thoroughly and impartially the legislative and administrative actions of government and elected and appointed government officials and to make known its findings and conclusions to the public would be a constructive, worthwhile move.

"However, to be effective, such a program would have to be motivated and guided by considerations of the public and national welfare and not by self interest or by previously formed political or sociological opinions of business organizations and business leaders."

Sun Oil Company, whose executives have long taken a leading part in politics, has demonstrated that this leadership can be followed down the line.

Robert G. Dunlop, president of Sun Oil, made this statement regarding Sun's company policy on politics:

"Sun Oil Company always has encouraged the participation of its employees, as good citizens, in the political activities of their communities and of the Nation. We believe that every citizen has a responsibility to inform himself in regard to all matters that have a bearing on the welfare of the American people, and to vote in each election held.

"From time to time we have presented to our employees and to our stockholders, for their information only, facts regarding undertakings that have an impact on the successful operation of the oil and natural gas business and on our economy generally. We shall continue to do so when the occasion arises.

"We recognize the right of each employee, as an individual, to affiliate with a political party or other group of his or her choice, and to work for the success of that party or group. We grant leaves of absence without pay to employees elected or appointed to full-time political offices at all levels of government for reasonable periods of time while they are engaged in such public service.

"This has been our policy from time immemorial in the belief that representative government is responsive to the wishes of the people only when the latter are informed and take an active interest in what their government is doing."

In describing its position in regard to political action, Standard Oil Company of California gave this explanation:

"If, by political action, you mean the election of candidates for office, our position is that the company, itself, can not legally engage in that activity, but it does encourage employees, as individuals, to take an active part in all civic affairs including the election of candidates.

"If the term 'political action' for your purposes includes ballot propositions bearing in some manner upon the successful operation of the company, our policy is to play an active part, directly or indirectly, in connection with all such proposals."

In answer to the query about whether the question of political activity was being considered, Standard (California) said:

"We are now and from time to time do re-examine our position as to what may properly be done in connection with the election of candidates."

Our third question based on Gulf's release was: "What do you think of the idea of setting up a program (a) to encourage shareholders and employees to become active participants and (b) to study official behavior of elected officials. Standard California's answer was:

"From time to time we review our policy on these two fronts, and are presently considering ways and means that can be used to encourage active participation by stockholders and employees."

All along the line statements of company policy carefully avoided any mention of union political activities. We were interested, however, in a statement by President R. L. Minckler of General Petroleum Corporation made in the

Some managements inform employees and shareowners of political issues

company magazine "Doings in General." It makes very plain that union political action is generally anti-capitalist. Mr. Minckler said:

"A few months ago, I wrote in this column about three aspects of labor union operations which I consider very dangerous. One of these is the activity of labor union leaders in political affairs.

"In California, we have an especially vicious example of this in a field far removed from normal labor union interests, that of taxation. The AFL-CIO leaders of California are sponsoring a tax measure, which will appear on the November ballot as Proposition 17. By its terms, this proposal will reduce sales taxes and state income taxes on low incomes and enormously increase income taxes on high incomes. The combination of these proposed state taxes and present federal taxes will result in practical confiscation of high incomes and will force wealthy and high income people to establish residence outside the State, if they can possibly do so, thereby losing them as useful citizens and taxpayers.

"Even if no one moves away, the reductions in the State's tax revenue in this proposal will exceed the increases by $52,000,000 per year. The State is already operating in the red . . . . .

"This dangerous proposal is properly condemned by all State officials, by all competent economists, by all business organizations and by all Democratic and Republican party leaders."

One of the most comprehensive programs described by various companies was that of Pan American Petroleum Corporation. President A. L. Solliday explained the thinking on the matter of political action by his company this way:

"While we do not have a stated policy on political activity, we have for years reminded employees of the privileges and responsibilities of the franchise, and have encouraged them not only to exercise their vote in every election, but to take an active interest in public affairs on the local, state, and national levels. These themes are carried out recurrently in such media as our company magazine, through individual letters, bulletin board posters and the like. Such particulars as voters' registration requirements and the dates of primary and general elections are called to the attention of employees in these ways.

"This year, as in others, we are again encouraging employees to exercise their voting responsibilities. And as usual, time off with pay will be given employees who request it in order to cast their ballots."

Then Mr. Solliday went on to describe a farsighted program the company carried out five years ago.

"In 1953, an entire series of employee meetings was given over to an intensive study of the American system of government. This program, which was made available to all employees, involved approximately six total hours of discussion-group sessions, moderated by college professors engaged by us during the summer, and keyed to the idea that it is the responsibility of the individual citizen to inform himself on candidates and issues, and then to act in accordance with his own thinking both at the polls and in other ways. Among the points covered was the mechanics of political organization, including the oft-neglected precinct meeting.

"While no detailed survey was made, we do know of a large number of instances where, as a direct result of this program, persons in our organization began to take a more active interest in political affairs. We know, too, of a number of instances where Pan American employees hold public offices in their local communities. On occasion, these activities are also publicized through our magazine.

"Employees are also given information on issues important to the industry, both on a state and national scale. This effort is often extended to include land and royalty owners where their interests are involved. Since Pan American is a wholly-owned subsidiary of Standard Oil Company (Indiana), we do not have occasion to communicate with shareholders in these areas.

"While we have for many years observed the voting records of elected officials, we have made no studied attempt to disseminate this information to employees. Doing so would involve more of an understanding than we are prepared to embark upon at this time. There is the consideration mentioned earlier that we believe this is largely a matter for the individual citizen to pursue, although we will continue to encourage him to find out the facts for himself and vote and act as his conscience dictates."

F. O. Koontz, president of Quaker State Oil Refining Company, said "We do not have a stated policy on political action nor do we believe it advisable to set up a specific program of action. However, we do feel that by continually bringing to the attention of those with whom we are associated their responsibility in this regard, we can be effective."

Mr. Koontz went on to say "We have during the past year called to the attention of our employees and distributors, (there are approximately 1000 of the latter) the vital necessity of participating actively in the political affairs of their communities and nationally."

Part of the Quaker State program has been the distribution of the famous letter written by Representative Gwinn of New York. In his message accompanying the Gwinn letter Mr. Koontz said "This is, I think, one of the most startling indictments I have ever read. Quite naturally it has given considerable concern to those who are aware of this situation. I have written my congressman asking if these are facts and would like to suggest that perhaps you would want to write your congressman along similar lines. It is a matter of grave importance to all of us and I wanted to be sure that you were made aware of this very critical condition."

More recently President Koontz wrote to Quaker State associates reminding them that it was time to work for those who "we think will best represent us. He pointed out that, "There are those in this country who would use any means to accomplish their desired political end . . . I needn't remind you that they are well organized and financed to do the job."

The Right Not to Vote

These companies, along with Gulf, have been outspoken in their belief that business must get into politics or politics will submerge business. At the other extreme is the stand of R. L. Tollett, president of Cosden Petroleum Corporation. Mr. Tollett's position is based on his belief—"The right not to vote is just as important as the right to vote in my opinion." He describes his company's position in this way:

"In the instance of Cosden, we are a publicly owned corporation with upward to 9000 stockholders. We do not know whether our stockholders are Democrats or Republicans, pro or anti-labor. We officers and directors are hired to make money, conserve it for reinvestment and distribution of reasonable dividends. I think it would be a violation of the trust our stockholders have in us for us to be making political contributions or spend any considerable portion of our working hours in politicing.

"You might say that our policy is to have no part whatever in politics, further than to generally encourage all employees to vote. We have not recently re-examined or revised our company policy, and see no reason to do so."

Gordon Simpson, president of Gen-

Businessmen's Complex

Raymond Moley (Contributing Editor of *Newsweek*), who has been urging businessmen to get into politics for many years, heard this recently from the head of a large corporation:

"But people don't like businessmen. They distrust our motives. We can't help in practical politics."

Mr. Moley's reply is a Practical Political Seminar in brief:

How to Do It

Here in essence was my answer; it is something to paste in your hat or over your desk:

"People like your product—they spend billions for it. It is the best in the world and they know it. They entrust their savings to your banks and insurance institutions. They buy more of the stock in your companies. They are your partners in progress. But they don't know you as a member of the community.

"You have been brainwashed by demagogues. You are attacked, not because you are a producer of good things but because they want to drive you into political inactivity. They want power for themselves.

"They have succeeded in making you believe that business and politics don't mix. But they are already mixed—in every law, regulation, and decision made in Washington.

"You spend great sums to represent your company there, but unless you do something your representatives will be talking to a Congress elected without your help. Power is where lawmakers, not laws, are made.

"How to do it? Get out in politics, working at the local level, and encourage your juniors to do it, too. Work at the local level. In the precinct or block or over the Congressional district. Go and see people in their homes and discuss politics—why they should vote and how. Go not as a representative of business but as a fellow member of the great, conservative, unorganized middle majority. Practically all of us are in that class now, as we are becoming an essentially classless society. In the great scramble we are all forgotten men."

Set An Example

"Work at the local level. Elections are won there, not by national 'trends' or mass appeals. You will be surprised at how easy it will be with those voters. Everybody likes attention and friendly contacts. Political power is on the doorsteps, the street corners, and in the living rooms of America.

"You as head of a big company must set the example. Your presence in the field will draw many, many of your junior executives, dealers, suppliers, and other friends. To work with you shoulder to shoulder outside of the plant or office creates a fellowship of equals in a common cause. This creates in your co-workers internal pride and external prestige.

"Labor unions have done this in politics for years. Thus they have built the most potent political power in the nation—dominating party organizations, dictating platforms, selecting candidates, and writing their own tickets in Congress and the State Legislatures. They did it by friendly, house-to-house contacts. Systematic employment of that indispensable element in politics—manpower.

"One final word. Don't attack, or high-hat, or ignore the party as such or the regulars who have labored for the party while you were not there. The party is what you make it, by your presence or your absence from politics. Reforming the party can wait a while. Help it first.

"When better members of Congress are made, you will make them."

Reprinted with permission from "Perspective" in *Newsweek*, September 29, 1958.

eral American Oil Company of Texas, went along with Mr. Tollett. Judge Simpson commented:

"As a company we have no stated or accepted policy on political action. We have not discussed company relations to or participation in politics. We leave those things to each individual. Personally I would think it unwise for a company such as ours to get into politics at all."

Reports from a number of companies gave various reasons for not stating a political policy. Every executive interviewed displayed intense interest in Gulf's decision. Several said their company was studying the matter and would have something to say about a political policy later.

For the present the subject of politics and business has thrown financial trends into the background.

Atlantic Refining Company says:

"The company does not have a stated or accepted policy on political action of a formalized nature. We have neither urged employees to engage in political activity nor discouraged them from doing so. Each case is handled on its individual merits. There has been a good deal of political participation by employees. We have cooperated with non-partisan organizations in encouraging employees to register and vote."

Atlantic Considers Action

Then it states frankly: "We are currently engaged in reexamining our position to determine whether a more formal company policy is desirable.

"We think the idea of setting up a program which, among other things, would encourage shareholders and employees to become active participants and to study official behavior of elected officials has considerable merit."

Many company magazines carry letters from the president or chairman of the board urging employees to vote and piously hoping they will vote right. The majority, however, are not as detailed as Mr. Minckler's or as forthright as Gulf Oil's.

One company which has a political action program of sorts has recently coordinated its activities at the national, state, and local levels. This company is also seriously considering practical politics seminars for its people.

Jersey Standard stated that it does not have a formal policy on political action and goes on to say:

"However, on numerous occasions Jersey executives have expressed publicly their conviction that businessmen have a responsibility to the community and nation. . . .

"Company executives have always encouraged the idea that employees undertake and perform as individuals the acts of good citizenship. Although we keep no records on the subject, we are sure that numerous employees serve in public bodies, take part in political campaigns, are members of organizations with political programs of some sort, etc.

"When legislative or administrative actions, which may affect the company's welfare, are proposed or taken, we may — in addition to exercising the right of petition by appearing before Congressional committees or other government bodies to give our views — communicate the facts as we see them to employees and shareholders, or state our views in speeches or other public statements."

Then Jersey makes the same point brought out in the Cosden statement:

"Jersey shareholders and employees represent a wide cross-section of political opinion. While they as individuals are free to take part in politics as they

Which has advantage — an announced policy or unpublicized goals?

wish, we do not feel that Jersey, as a company, should engage in politics in the sense of supporting a particular party or candidate."

Need to Educate Congress

M. J. Rathbone, president of Jersey, two years ago before the Newark Rotary Club covered a neglected subject—the need to educate Congress about business problems. Said he:

"It seems to me . . . that businessmen have the specific responsibility for seeing that members of Congress know what makes business tick. The business organizations and industrial plants of a state or a congressional district are vital to the areas, and are entitled to proper representation by legislators. But these men and women must have knowledge and background to provide such representation. As individuals, ask your Congressmen and Senators to visit your plants and offices. Show them what you make or do, and explain the economic and social importance of it to your community. If they are good lawmakers, they will ask questions and, in their own way, reach a better understanding of your aims and problems."

Later in the speech Mr. Rathbone made a point that should be remembered by businessmen as well as legislators. He said "After all, business is a chief ingredient in many of the principal interests of our lawmakers—the maintenance of employment, progress in research, the extension of technology, and the defense of our nation."

Legislators, local and federal, are constantly reminded by alert union leaders of the needs and desires of labor. The problems of business management are generally presented in defensive testimony when the case is in jeopardy and already half lost.

Shell Oil Company began its statement with the comment that the company had always carefully avoided taking sides in local political issues, but management has for some time encouraged employees to do their duty as citizens to serve on school boards and other local committees and commissions such as highway and traffic safety groups. At general election time the company occasionally urges all employees to exercise their right to vote.

The statement continues: "With no encouragement from us other than the knowledge that Shell is not opposed to their doing so, many of our employees serve on town councils and school boards, and even occasionally as mayors in small communities where this is a part-time job that can be done in the evening."

In regard to keeping company people informed on the performance record of elected officials, Shell wrote "We are inclined to think that it is the responsibility of employees to keep themselves informed of activities of their political representatives through the local press and other means of communication open to them."

Sunray Mid-Continent limits its political activity to getting out the vote. In an interview carried in the Sunray News with M. Darwin Kirk, vice president and general attorney of Sunray Mid-Continent, he made an early plea for participation:

"Few of us are thinking much at this time about electing the city, state and federal officials who will be later charged with taxing our properties and earnings and guiding the policies and practices of our governments.

"None of us can deny that the governments — national, state, and local — have their effect on almost everything we do. What can we as individuals do to help assure good government?"

R. I. Galland, president of American Petrofina Company of Texas provided this information:

"We do not have a stated policy. Our accepted policy is, however, that employees are encouraged to participate freely as responsible citizens and residents of their communities. This necessarily involves their participating in political activities. We have not attempted to influence individual attitudes."

In spite of the lack of formal policies in many companies, there is increased interest in politics and increased determination to have a say in political matters. The Texas Company, for instance, has always followed a very conservative line in political action. Yet in recent months James H. Pipkin, a vice president, has been moved to Washington to head an office there. Several companies, in fact, have offices in Washington where they can keep close attention on matters that affect them vitally.

In one particular phase we have seen a change in the last couple of years. Many companies in the past never responded to criticism. Company managements are not so silent as they have been. They are stepping up and putting their positions on record. The statements about the indictments at Alexandria are not the pantywaist type. Most companies have protested vigorously and presented their case well. How many read beyond the fact of the indictments, it is hard to say. That does not change the fact that conservative attitudes have come a long way toward the concept of political action.

On the whole, we get two specific objections to an announced political policy. The first one is a cautiousness instilled by the Federal Corrupt Practices Act and, in a lesser degree, by state election campaign laws.

Union Leaders Bolder

The more powerful union labor leaders have not been intimidated by these laws and they have managed to get judicial approval for their bolder campaigning.

A second objection is one that has been repeated several times by companies who say they have no political policy. This is the disadvantage of "telegraphing your punches." There is no doubt that you have to have stronger purpose and a better follow-through to afford to state what you intend to do and then do it. We must remark that so far untelegraphed punches have also been invisible in effect.

The weaknesses of unpublicized decision and action are chiefly that (1) there is no opportunity to enlist your well wishers and perhaps the fence sitters and, more important, (2) with an announced goal you can set up no standard for success or failure. (Or, like Parkinson's Injelititis,[3] the goal is scarcely worth achieving.)

Along with this idea of not publicizing your intentions is that if you voice a definite stand the opposition will focus on you, and you'll have to take the first blows. All we can say to this is, if there are no first-line soldiers, there is no army.

A Washington writer for the *Dallas Morning News* reported that labor political leaders are showing increasing concern over announced plans of business to form political action organizations. At the same time, the union officials were highly elated over elections so far this year. In its "Political Memo" COPE said "Voters are voting for candidates who are proved liberals—that seems to be the good news about the September primaries."

The *News* report goes on to say "While labor shows concern over the political stirrings in the ranks of business, it is yet too early to determine whether the new conservative action groups will become dynamic and effective forces.

"If they fail, the liberal movement may become an avalanche, because labor has proved it knows how to mobilize politically."

[3]Parkinson's Law, by Professor C. Northcote Parkinson, Houghton Mifflin Company, Cambridge, Massachusetts. Highly recommended reading for executives. ★ ★ ★

ONLY THE SKILLED CAN WORK

There is no place for an untrained person in the petroleum industry. One of API's big contributions is its extensive organization for training . . . Distribution of knowledge might be called the Institute's most important product

SAID A BRITISH ENGINEER: "I doubt if there is another country in the oil areas of the world where a group could get together and hear men from competing companies give the benefit of their successful developments to all without restraint. The willingness to share must be one of the reasons that the American oil industry has led the world."*

Once an independent producer said to us, "The oil industry gives away a billion dollars worth of information a year."

We agreed that was true and added, "But we give it to each other."

The American Petroleum Institute has organized this generosity into a very efficient distribution of knowledge. Through courses set up by committee members, modern techniques are taught to old hands who grew up in the industry and to newcomers who know little about it.

Technology Schools

The most formal of these courses are the four schools of technology. These deal with fundamentals and require six weeks time. They are given each spring and fall. The tuition alone is $300 and living expenses are added to that. Two of these are sponsored outside API but they are all four run in the same way.

There is no question in the minds of most company management of the value of these schools. The number of applications are indicative of the interest in the courses.

*Quoted from a paper given before WPRA by John Woodruff, Petroleum Extension Service, University of Texas.

Here are the schools, sponsors, their headquarters, and dates of the latest sessions. (All schools are held spring and fall.)

School of Drilling Technology—Odessa (Texas) Junior College, sponsored by AAODC, October 6 - November 14.

School of Production Technology—sponsored by API, Division of Production—Kilgore (Texas) Junior College, October 6 - November 14.

School of Gas Technology—sponsored by committee of individuals representing gas companies—Conroe, Texas, September 22 - October 31.

School of Pipe Line Technology—Robert E. Lee College, Baytown, Texas, September 15 - October 24.

API's production school is in its seventh term. Only the drilling school of AAODC has been going on longer. It began in 1954 and is in its ninth term.

R. A. Brannon, chairman of the Committee on Personnel Training for API Division of Transportation, reported on the pipeline school in 1957 and he gives us a good idea of the school's worth and history.

In the first school in the fall of 1956 there were 37 in attendance. These represented 25 companies, two government services, 12 states and six foreign countries.

There were 40 instructors from 23 different companies.

The study outline for the school is the most complete coverage of the pipeline industry we have seen. Not only does it go thoroughly into techniques but it begins with a broad framework of company organization, government relationships, conservation, economics, outlook—the things a pipeliner must know if he is to see the goal as well as learn the means of reaching it.

Brannon concluded: "There can be no doubt that enrollees, and through them their companies, receive much benefit from attending the school. A question might arise as to whether the companies contributing the services of instructors receive benefits commensurate with the expense, effort and em-

R. A. Brannon is chairman, Committee on Personnel Training, Division of Transportation, API. He was employed by Humble Pipe Line Company in 1928 and has been with them ever since. He is now supervising engineer.

A native Texan, Brannon studied chemical engineering and business administration at the University of Texas. He received his BBA degree in 1928.

R. E. Foss, chairman, API Central Committee on Training, is vice president and director of Sunray Mid-Continent. With a mechanical engineering degree from California Institute of Technology, he went to work in California oil fields as a roughneck during the depression years. In 1935 he joined Barnsdall as a junior engineer. He moved up to vice president in charge of West Coast production operations, which position he held when Barnsdall was merged with Sunray in 1950.

ployee time contributed. In common with most group efforts of this sort, the instructors learn as much as the students and probably benefit more than they do."

Vocational Training Courses

API's Division of Production Training Committee has a list of short courses on tap that can be given at any time enough persons want one of them in a specific area. These run all the way from 3-hour courses, like "Lubrication of Oilfield Equipment," to 30-hour courses given in two weeks.

Subject matter for these courses is studied and outlined by special committees before being sent to Committee on Vocational Training and Central Committee on Training for approval.

At the present time J. C. McClure of Cities Service Oil Company, Bartlesville, is chairman of a special committee to develop a Salt Water Disposal manual. Roy Willis, Atlantic Refining Company, Dallas, heads another committee appointed to prepare a manual on Gas Lift. A third manual on Well Testing is also in work.

One new course, Prevention and Control of Blowouts, got a trial run in Lafayette, Louisiana, in September and was booked for Odessa in October. It is a two-day course, sponsored by both API and AAODC. Among requests for the course already received and approved are from groups at Farmington, Denver, Rock Springs, Casper, Billings, Glendive, and Williston. The course will be given in 16 cities.

A popular subject like Treating Oilfield Emulsions may run once a month in various areas as it did this fall.

Electricity and Electrified Lease Operation, another 30-hour course had bookings for three months in a row.

Usually one company takes the initiative and anyone in the area who wants to attend may do so.

These courses are handled by different schools and their extension services and the company or group interested in the courses gets in touch with the school directly and together they set a date. University of Texas and Oklahoma Extension Service staffs conduct API-sponsored courses in the Mid-Continent. Experienced oil men in other areas are called on to make up the faculty.

Besides specialized courses there are a number of general courses. These are less popular now but material for giving them is still available.

TABLE 1. API-Validated Vocational Courses.

No.	Subject	Cost material[1] per person	Length of course
	General		
B-2	Applied Mathematics for Petroleum Industry	$2.00	48 hours
B-3	Elementary Science	1.00	48 hours
S-2	Production Practices	1.50	96 hours
S-4	Natural-Gas Production	1.50	96 hours
S-6	Oil Pipeline Transportation		
S-8	Conf. Leader's Guide for Foremanship Training	2.00	40–60 hours
G-5	Electric Power	.75	48 hours
T-1	Technical Practices in Petroleum Production		
	Specialized		
	Treating Oilfield Emulsions	$3.00	30 hours
	Care and Operation of Pumping Engines and Units	2.00	20 hours
	Handling and Running Casing	.50	3 hours
	Field Handling of Natural Gas	3.00	30 hours
	Care and Handling of Sucker Rod Pumps	.50	6 hours
	Care and Use of Sucker Rods	1.00	3–4 hours
	Care and Use of Wire Rope	.50	3 hours
	Lubricating of Oilfield Equipment	.60	3 hours
	Vapor and Gravity Control in Crude-Oil Prod.	1.50	3 hours
	Waterflooding	1.50	20 hours
	Electricity and Electrified Lease Operation		30 hours

[1] Manuals for courses are published and distributed by the Divisions of Extension of the University of Texas and University of Oklahoma and by the California State Board for Vocational Education.

Supervisory Development

Six district Committees on Supervisory Development in the API Division of Production are a medium for the exchange of ideas and information on developing supervisors. These groups also supply speakers to oil industry groups or sponsor forums for the purpose of reminding management of its obligations in this field.

Products of the district committee worthy of publication for industry-wide reference are issued in the API Division of Production "Guide to Training." Some of the articles produced in the last five years for the guide are as

Louis F. Davis heads the API Committee on Vocational Training. He has been with Atlantic Refining Company since 1935 and is now manager, regional divisions, Domestic Producing Department.

Davis received his BS degree from the University of Texas in 1934.

J. V. Blacklock, Humble Oil and Refining Company, Houston, Texas, was appointed chairman of API National Committee on Supervisory Development, succeeding R. W. McIlvain, Pure Oil Company, Chicago.

Blacklock joined Humble in 1929 after completing study in Business Administration at the University of Texas. He is presently Coordinator of Personnel for the Production Department.

follows: Suggested Guide for Developing Newly Appointed Supervisors, Pre-Foremanship Program, Evaluation of Training, Determining Training Needs, Techniques of Instruction, Training Aids, Glossary of Training Terms, Supervisory Development Services Available, Training Engineers to be Supervisors, Planning and Preparing Training Programs, and Coaching.

The articles result from many man-hours of research, preparation, discussions and review before qualifying for publication. Many years of experience are behind the committee members formulating the material.

The committee feels this guide will be of direct benefit to supervisors in the industry interested in developing their people.

Training in Refining

A somewhat different situation exists in refining than in transporation and production. Groups employed at a refinery are usually larger than those in production and pipelining and the personnel is not moved about. Training can be undertaken on the job. So the Division of Refining's Committee on Training works mainly as a forum for upgrading the caliber of refinery training personnel and secondarily as an agency for collecting and making available, from a central source, vocational training materials.

Part of this consists of a library reference that gives an idea of the vast amount of training materials and literature available from oil and supply companies. Most of these are training manuals like Standard (Indiana) Boilermaker Manual No. 1 for petroleum refinery worker.

Texaco has 17 basic training courses on various subjects — such as "Basic Training Course on Centrifugal Pumps for Machinists."

Standard (Indiana) has extensive guides and manuals and, in addition, an 11-part series on economics and literature for a supervisory training conference.

Texas A & M College provides material for a complete "Fundamentals of General Refining Practices" course in 14 sessions and six manuals that cover "Natural Gasoline Plant Operations and Technology."

Participation in the library is, of course, voluntary. Three copies are sent to the library at the New York headquarters where they are classified and listed for use.

These can be borrowed from the library upon request and the staff can give permission or can arrange for reproduction of specific items. There is no charge for the service, only for reproduction costs.

The Refinery Division's Committee on Training has this year been strengthened by the addition of supervisors and managers from the line organizations. G. S. Dunham, director in charge of manufacturing, Socony Mobil, is sponsor of the committee.

Currently, the committee is working toward the preparation of training courses in instrumentation which will reflect the tremendous advancement that is being made in this field. It is also working with the Foundation for Instrumentation Education and Research toward a program for refinery personnel charged with the teaching responsibility. This project is under the direction of H. G. Abbott of Esso Standard Oil Company.

Another current project is the preparation of a manual on "Training Organization and Practices." The project is under the leadership of W. O. Barnes, Tidewater Oil Company.

Marketing Training

In recent years the vocational Training Committee in the Marketing Division of API has worked with DE — a national distributive educational program carried out by state-federal cooperation.

So far only a few of the 30,000 young men and women enrolled in this program have chosen service station work but the opportunity is available.

If a high school student selects to take the DE course and selects the service station business, he divides his time between classroom and on-the-job training. The dealer is usually selected by the high school and he must give supervision and instruction on all phases of service station work.

So far in only five states have local men organized to interest students in the DE course. Experience with DE students has been highly favorable and oil marketers are urged to take the initiative in getting recruits for the course.

Area Training

In California the API approach to education differs from other areas. Several colleges — Long Beach City College, and junior colleges in Ventura, Coalinga, Fullerton, Bakersfield, and Taft cooperate with API in giving regular college courses in the evenings to oil personnel. These may be taken for college credit if the student is qualified.

These courses cover various phases of the industry. There are such subjects as "Pipe Fitting" for Refining Practices, Petroleum Production Practices, Oilfield Mathematics, Elements of Supervision, Oilfield Corrosion Control.

Some classes meet weekly; others twice a week for the semester.

Chairmen of the committees are also on an area basis. R. L. Andrews, Standard of California, is chairman for Los Angeles Basin area; Jack A. Biren, Conoco, is Ventura Coastal area chairman; Don Craggs, Union Oil Company, is chairman for the Coalinga-Kettleman area; Eugene E. Nichols, is chairman for the Bakersfield area; and chairman for the Taft area is Jack Rogers, Honolulu Oil Corporation.

John J. Stadtherr, Training Director of the API Refining Division, has been training director of Pure Oil Company, Refining Division, since 1949. He has been with that company since 1937.

Stadtherr was graduated from the University of Missouri with a BS and did post-graduate work in chemical engineering at Ohio State University. From 1927 to 1937 he was with Sinclair Refining Company at Coffeyville, Kansas.

Another medium of teaching widely used by API is films. This includes everything from general industry-wide movies, to supervisory development films, to filmed descriptions of highly technical operations such as electrical well logging. You'll find a film for almost every need available through an API loan service.

Companies contribute films as well as literature in API training program.

The whole program is based on voluntary cooperation, using the Institute as the framework for the working organization. There are usually 200 to 300 men serving, depending upon the number in special temporary groups to set up new courses, and on the Central Committees on Training or the Committees on Vocational Training and on Supervisory Development. The chart showing the Division of Production organization gives you a good idea of the plan.

The success of the training program naturally depends on the active interest of those involved. That it has helped many people improve their future in the complex petroleum industry has already been proved.

The usefulness of the program depends largely upon the extent it is used.

★ ★ ★

C. Z. Hardwick

Franklyn Waltman

Richard Rollins

Kerryn King

Let's Take a Look

This round table talk brings together the opinions and ideas of men who headed OIC activities during its organization. They and API President Porter and CPA Chairman King discuss the industry's public relations — past and future.

FOR NEARLY 40 YEARS, the American Petroleum Institute has been a unique educational force within the industry, searching for new techniques, promoting better operational methods, spreading the gospel of efficiency in development of oil resources, and acting as a source for information about oil.

During 25 of these years, it has attempted through its American Petroleum Industries Committee to — among other things — keep oil men informed about governmental matters affecting their interests and those of their customers. In the process of doing this, it has tried to present the facts on the issues, and has increased public understanding of the industry's position on public issues.

Then in 1946 a public relations survey shocked the petroleum industry! We were not wholeheartedly approved. The public had created its own ideas about the oil industry. These ideas were not always true and the industry considered the truth was far better than the public's professed beliefs.

So the Oil Information Committee was organized. Its job was to replace fantasies with facts in the minds of the people. After 12 years the API Board of Directors decided to merge APIC and OIC into a Committee on Public Affairs.

This is a big move. Nothing is quite so important right now as the industry's relations with the public. We ask the men whom we think know the most about the OIC to give us their opinion of its past and the possible future of CPA. We must know how we have fared and know how we can use the new tool for better public relations. The industry may be confronting its last opportunity to save itself from being swallowed by government controls.

Round Table Group

President, American Petroleum Institute — Frank M. Porter.

Present chairman Committee on Public Affairs — Kerryn King, vice president and general manager, industrial and public relations, The Texas Company.

Former chairmen of Oil Information Committee —

C. Z. Hardwick, executive vice president, Ohio Oil.

Richard Rollins, secretary and director of public relations, Atlantic Refining.

Franklyn Waltman, director public relations, Sun Oil.

W. R. Huber, former director public relations, Gulf Oil.

M. S. Hauser, manager public relations division, Ohio Oil.

Thomas W. Phelps, manager economics department, Socony Mobil.

at API Public Affairs

Q. *What do you think of the OIC program and its results?*

W. R. Huber

M. S. Hauser

Thomas W. Phelps

Frank M. Porter

MR. PHELPS: The objective of the OIC program was to preserve conditions under which our domestic oil industry could continue to be privately managed, fully competitive and financially sound. I doubt if a better objective can be stated for the new Committee on Public Affairs. In implementing the program, the OIC placed great stress on obtaining the widest possible participation by oil men and women. That, too, was sound, and should be continued. This is not a job for a few highly paid mercenaries.

Many mistakes have been made in the execution of the OIC program. But like everyone else, we in the oil industry get our good judgment from experience, and our experience from bad judgment. We learn by our mistakes.

One of our mistakes was to try to separate public relations "fire fighting" from public relations "fire prevention." That is, we tried to have one group do the long-rang educational job while another met the current issues. Too many balls fell on the ground between the two, but the merger of APIC and OIC corrected that mistake, and I don't think we'll make it again.

Another mistake was to confuse the means with the end. Too often we seemed to regard advertising or motion pictures, for instance, as goals in themselves rather than as tools to help us reach our goals. In that respect, too, we have learned better.

Those who criticize the OIC program on the grounds that in 12 years it has failed to solve the industry's public relations problems should go to Holland. The dikes around that country have not lowered the ocean an inch in the last hundred years, but a great many tulips have been harvested on land below sea level in the meantime. If public opinion of the oil industry is no worse today than it was 5 or 10 years ago, that may well be the OIC's most noteworthy achievement. Holding the line can constitute a victory just as real as gaining ground. It all depends on the circumstances, as the Germans learned at Stalingrad.

MR. WALTMAN: Looking back over the last 12 years when I have had rather close association with industry-wide public relations efforts, I regret to say that they have lacked the realism that I thought the situation required. The Oil Information Committee never really came to grips with the public relations problems that gnawed at the vitals of the industry—such issues as increasing government encroachment on the freedom of action of the oil and gas business, the widespread misunderstanding of the statutory depletion provision, misunderstanding and distortion of oil prices and profits.

For some strange reason, these problems were regarded as current or short-range and were classified as belonging in the "fire fighting" category, whereas OIC increasingly was restricted by the API authorities to dealing with so-called long-range issues upon a low-pressure educational basis, an effort called "fire prevention."

MR. HARDWICK: So far as I can see there has been steady improvement in practically all the areas of the OIC program and it is a long-range program. At times, many people are inclined to criticize it without knowing the job itself is one that requires continuous effort over a long period of years.

MR. PORTER: The OIC program represented the best thinking of some of the most qualified people in this industry, in terms of what might be done in this field. I think it was a basic contribution to better relations between the petroleum industry and the people it serves.

MR. ROLLINS: Within the limited field in which it was permitted to oper-

ate, the program has been useful and I think successful. But a "long-range, low-pressure" program cannot show tangible results in the short space of 10 years. It is, however, a pity that the very real talents and abilities of many of those serving on OIC were not used (through API restriction) to cope with current problems.

MR. KING: The Oil Information Committee activity was one of the most constructive efforts ever undertaken by any major industry. Most of its shortcomings were attributable to factors beyond the control of those responsible for its operation. But these shortcomings are both obscured by its accomplishments and remedied in the charter of the new Committee on Public Affairs.

The OIC program awakened the interest of companies, large and small, and oil men at all levels, to their public relations problems. The rewards from its establishment will be felt for many years to come.

Q. *What in your opinion stands out as the most important achievement of OIC?*

MR. PORTER: Awakening the industry to a realization that we face some fundamental public relations problems, and, equally important, that we are going to have to stand and meet them together. This constitutes a truly significant achievement.

MR. WALTMAN: Many divergent groups in the industry, brought together through OIC activities, reached a clearer, firmer understanding of the need to achieve and preserve a climate in which competitive enterprise and individual opportunity can survive. An outstanding school program has been established.

MR. ROLLINS: A fundamental concept of the program was that it be carried out by the people of the industry—not by an agency. Some 50,000 oil men and women across the country were enrolled as members of OIC committees. If only half of them are really active, this is, nevertheless, a step toward the goal of giving all in our industry a better understanding of how it operates and a realization that each can and should be an ambassador.

MR. HUBER: One thing that impressed me greatly was the fact that through OIC oil men at the local level had become better acquainted. They learned to know each other and have respect for their competitors. This friendliness, however, in no way lessened the strong competitive spirit with which each went after business, but they stopped calling one another bad names. As a result, they joined forces in activities that were intended to help the industry generally.

MR. PHELPS: OIC's best accomplishment was enrolling oil men and women as active participants in the industry's effort to achieve better public understanding of its operations.

MR. HAUSER: Two achievements stand out: OIC sparked a much better and wider appreciation of the dire need of better public relations for the industry by industry members, and it developed an organization in the field made up of industry people to carry out the program.

This may not have been 100 percent effective but the machinery was pretty well developed and the people derived a good deal of valuable experience in the work. As to programs, probably the most effective single one, and one with still greater future prospects, is the school program.

MR. KING: Most important to me is an awareness on the part of the industry of the need for a continuing communications program, backed by organization and energy.

Q. *In other words, you don't think the program was a failure?*

MR. WALTMAN: No, although OIC failed to achieve its goal, the effort was far from a complete failure. Actually OIC was the first effort of the oil industry to achieve a united public relations front. Many in the industry have been made conscious that the survival of our business depends on what people think of us.

Neither the money nor the effort expended through OIC was wasted. But the time has come for everyone in the oil and gas business to do more to achieve public understanding and favor and to do it more intelligently.

MR. PHELPS: Like most of us in life, the OIC program failed by a wide margin to achieve all that it might have in the bright light of hindsight. On the other hand, if the oil industry could live over again the years since 1946, without the OIC, I believe the money thus saved would look awfully small compared with the difference between the way things are and the way they might have been.

MR. KING: No program by OIC, or for that matter the Committee on Public Affairs, will *eliminate* public relations or legislative problems. Hopefully, we are now organized to handle these problems *more effectively*.

Q. *What do you think of the new plan?*

MR. KING: The new Committee on Public Affairs is a sounder organizational approach to the same problems formerly handled separately by the OIC and the APIC. While 1959 will of necessity be somewhat of a "shakedown" year, the CPA will carry on the most important programs of both former organizations and, at the same time, try to gear itself to handle on an improved basis the attacks on the industry at both national and state levels. However, if this latter program is to be effective, CPA will need support and direct action by individual companies.

MR. HUBER: In my opinion, the competitive spirit that held under OIC will continue under the new setup of

state organizations. Undoubtedly, the oil men will participate so that there will be increased activity all along the line.

MR. HARDWICK: I think the new plan of consolidating the former OIC and PIC is highly constructive and can result in improvement from the efforts of the people involved.

MR. PHELPS: I am all for it, as an organization plan, but no organization plan is a substitute for earnest, intelligent efforts on the part of individual men and women. I particularly like the decentralization of authority and responsibility by states, but as in our federal union, we must coordinate our efforts on major matters if we are to be fully effective.

MR. WALTMAN: At least on paper, the new set-up, in my opinion, is a vast improvement over the apparatus that previously existed. Whether it will prove itself to be that depends, it seems to me on three things:

1. The earnestness, determination and intelligence with which each oil company backs up the effort and utilizes the new apparatus.
2. A realization that the industry can win sympathetic and favorable consideration from government only after it has restored a favorable public opinion toward its operations.
3. The ability of the leaders to reconcile differences of opinion within the industry, or at least to subordinate such controversies to the far more beneficial and important goal of keeping the industry free to operate within a competitive enterprise framework.

MR. HAUSER: I think the particular change in organization to improve results has now been made, namely, the consolidation of APIC and OIC. The national OIC has long felt that you can't separate long-range (OIC) activities from the short-range (PIC). So you can see that I think the new plans are okay and I foresee an improvement. Naturally, it is going to take time, good leadership and a lot of hard work both at national and state levels before we begin to get results.

Q. *How will it work?*

MR. PHELPS: Mr. Porter and Mr. King should answer that one.

MR. PORTER: This will depend upon the people involved. If it is to succeed, it will demand the unflagging efforts of every man in the oil business who has the good sense to know what's at stake and the fortitude to stand up and speak his piece. This is a common cause which will be accepted by every segment of the industry, or will fail.

If we fail, the penalty will be an extension of governmental control over private affairs which will reach right into the American living room. If we are not to fail, every possible effort of everyone in this industry must be directed toward the support of freedom of enterprise.

If there are people within the industry who expect CPA to solve their individual problems for them, they will be disappointed. Those who see CPA as a panacea, somehow, for the misunderstandings which have grown up between the industry and the public will likewise be left unhappy.

What CPA is designed to do is to provide a focal point for common problems and a mechanism to help solve them. But it is only a mechanism. The actual handling of the problems which beset this industry can be entrusted to just one group—the people who have the problem staring them in the face.

CPA is not intended to operate in any area where the companies or individuals can and should function for themselves. It is established to give the men on the scene every possible assistance within its capabilities in the way of coordination, suggestion and working materials, and this assistance is available to every organization within or outside the industry which shares our concern with the problem.

The challenges that we are trying to meet will demand the best efforts of every one of us.

MR. KING: Basically, the CPA provides a forum where responsible industry executives can discuss problems and determine basic objectives, plans, and programs. Oil men in each state have organized State Committees to operate independently and handle public and governmental informational functions in that area.

But again it must be stressed that individual companies and oil men must be prepared to deal with public relations and governmental problems which are of an individual nature and not common to the industry.

MR. WALTMAN: I'd like to add something here: If the industry—and I refer to the integrated companies as well as the smaller marketing and producing units—take the view that the API Committee on Public Affairs can or will solve the serious governmental and public relations problems now threatening the survival of all segments of the oil and gas business, then little that is constructive will be accomplished.

It will not be enough for companies, partnerships and individuals to contribute dollars and give only lip service to this new undertaking. OIC was adequately financed and had pretty much unanimous lip service, yet it failed to stem the tide arising against the industry.

Another point that should be made: If we wish people to put their faith in our stewardship of this vital industry, we must have faith in them. This means we must stand up and talk to them about our mutual problems in terms that they can understand.

The hush-hush attitude about matters of public concern that now chills so much of the effort to achieve better public understanding should be abandoned. We must talk to people regarding these matters of public concern frankly and intelligently. Nothing is to be gained by condemning or brushing off every critic of the industry as a contemptible scoundrel, when all that is needed are factually truthful statements.

Q. *Just how can individual members of the industry help in our public relations problem?*

MR. PHELPS: First, by enlisting as participants in the program in their own communities, and then by training themselves to fight effectively in the never-ending battle for men's minds. Falsehood and misrepresentation are most effectively countered when most promptly challenged.

Just as one man stamping out the first tongues of flame in a dry forest may be more effective than an army fighting full-grown conflagration, so individual oil men and women scotching untruth in the bowling alley or over the bridge table can be more effective

than company presidents taking up the same issues weeks or months later.

And while we're talking of how individual members of the oil industry can promote the common good, let's not overlook the fact that this kind of industry service benefits the giver, too. When two men are being considered for promotion to the same position, it is the "pluses" that decide which one. Demonstrated ability to lead and persuade is a universally appreciated "plus." Working for the industry in the OIC program, like working for one's community, has given many oil people their chance to prove and improve their "pluses."

MR. ROLLINS: If everyone in the industry will undertake to do his part in his own community, to know the facts and tell the facts about the oil business, the program will be successful. It cannot be done by remote control. It will take time, and the results will be hard to evaluate, particularly in the first few years, but they will be there.

MR. WALTMAN: Very seriously, I believe that the industry now confronts one of its last opportunities to save itself from entanglement with the socialistic processes of government. It can succeed in doing so if its people make the proper effort. If they do not make the needed effort they well may lose that freedom which enabled the oil industry to serve America and become great.

Each state now for the first time has an autonomous organization of oil men and women to carry forward this crusade to preserve oil's freedom of choice and action. No longer can blame for failure be laid upon a centralized committee in far-away New York. If there is overall failure—then it will be due to apathy or stupidity of all oil men and women. Such is unthinkable unless we first accept the harsh judgment that we are unworthy to hold and keep that which our forefathers achieved in the last 100 years.

MR. PORTER: Individuals can help by recognizing that they are being called upon to defend one of the cardinal principles in the American way of life — competitive enterprise — and by acting in such a way that they constantly reflect credit upon their industry, which typifies this principle.

What people think of the oil industry is dependent to a very great extent upon how oil men carry out their business and what they say about the industry to their fellow citizens. If the individual oil man will simply take advantage of each opportunity to correct misunderstandings about the industry, this in itself will stand as a major contribution.

MR. KING: Every company and every employee needs to take a good, hard look at what they are doing and decide whether such actions are a plus or a minus so far as public attitudes toward the oil industry. A few minuses can offset a truckload of pluses, as we have seen all too often.

And if we are doing a good job, let's make sure that our neighbors and friends know about it.

Public Affairs Organization

API's Committee on Public Affairs is presently in the stage of developing its formal organization. Each state will have its own organization and this work has not as yet been completed. Sometimes mergers were effected with existing associations. In Texas, for instance, the Texas Mid-Continent Oil and Gas Association handles most of the jobs usually undertaken by APIC. Here the OIC activities were merged with the Texas Mid-Continent Oil and Gas and it will direct the oil industry's activities with state governmental and legislative bodies as it has in the past, and also promote the industry's publicity and educational campaigns. This process of setting up state public relations entity, however ,is not fully completed at this time. On the national set up the Committee on Public Affairs, headed by Kerryn King, will direct overall publicity and educational programs from the New York headquarters.

One addition to the new program, which promises to be helpful, is the appointment of Frank L. Dennis to the job of assistant to the API president in the national capitol. This is the first time that API has had an authoritative voice in Washington. The Institute has always had a Washington staff, but no one to head it.

Dennis has had a varied career including that of an executive of the *Washington Post*, public affairs officer for Clare Boothe Luce when she was ambassador to Italy, and president of a corporation which this year opened America's first complete wax museum in Washington. He has also been director of information in Europe for the Marshall Plan and a practicing Washington attorney.

Most recently he has been director of the press and publications division of the U. S. Information Service.

A former assistant managing editor of the *Washington Post* with 19 years' residence in the capital, Dennis has a wide knowledge of government workings. He is a member of the District of Columbia Bar and the National Press Club.

Dennis, the son of an oilfield carpenter who put together the heavy timbers for rigs, is a graduate of Oklahoma University and a law graduate of Harvard Law School.

How to Accomplish More With Less Work

Successful, busy executives in the petroleum industry follow this formula to keep work up-to-date with less effort

Jack E. Bedford

TOP MANAGEMENT and middle-management in the petroleum industry who keep up-to-date on their work follow a simple formula. This idea keeps their schedule current and is flexible enough to make it easy to handle unexpected situations that develop without disrupting the complete routine.

Successful executives have followed this plan for a long time. It is not new — it is time tested as a technique of modern management. The formula has these three parts: 1. Refer, 2. Defer, 3. Delete.

REFER

When an executive refers a duty to someone else in the organization, it can be a time-saver for everyone. This can be done to avoid a time-wasting task, to bring special skills and abilities into the picture, or to train another man to take on responsibilities.

For instance, a top executive is called on to give a speech. It is an honor and good public relations for the firm. It cannot be deferred or deleted — it must be done.

Some executives will spend a day, two days or a week in writing the speech. It will be good. But, in 20 minutes or a half-hour it is over. The time and the dollar cost of this executive task may be tremendous. And, during this speech writing time many more important tasks and decisions may be deferred.

However, the successful executive who follows the management formula will refer this to someone else. It may be the public relations department, the advertising department, or a ghost writer who works on a fee basis. By referring the job to someone else, the executive has a day, two days or a week that can be devoted to top level management decisions that will build profits for the company.

Another time when it is best to refer the task to someone else is for executive development. For instance, a production schedule or a sales budget is needed. In deciding whether to do it himself or to refer it to another man, the time element will enter the picture. The top executive knows he can do the job quickly and efficiently. He is better qualified than anyone else in the firm to handle the task.

When the executive refers the work to someone else, however, he is providing executive development. The person who is assigned the job grows in management stature. He learns how to prepare the budget or schedule. He gains self-confidence . . . and his loyalty increases many times.

A maxim of successful management is: When two partners always agree — one is unnecessary. This is another time when referral may be the best management strategy. Some management-minded executives follow the practice of always referring important decisions to someone else.

This provides another viewpoint and helps make the final decision better. And, with the referral of the decision to someone else, the top executive can study the problem more objectively and perhaps provide the necessary checks and balance needed for wise management.

DEFER

Successful petroleum executives do not "put off" 'til tomorrow tasks that need to be done today. Yet, on every executive's daily schedule there are items that do not have a deadline. These are the items that can be deferred to provide more time for the "must" items and special situations that do develop during the day.

For instance, many tasks facing an executive are in the "when I have time" category. A sales budget, due the first of December, for instance, might be on an executive's schedule in October. He thinks about it, but because there

Mr. Bedford is Professor of Management, Armstrong College, Berkeley, California.

isn't much urgency, puts off actually doing it.

This is not what is meant by defer. Each day a task is deferred this way it takes time. It uses up a certain amount of concentrating time of the executive each day it is deferred. A better way of handling this is to defer it to some specific date in advance of the first of December deadline.

Another time when petroleum executives can use the defer phase of this management formula is when there is not enough time to complete the job. For instance, some management tasks require considerable time. There is not enough time to complete this job and still handle other more urgent work. It is best to defer this to a later date when there will be plenty of uninterrupted time to complete the job.

Don't "put it off" . . . transfer it to some better time.

DELETE

Every executive has some things on his daily schedule that are not necessary. Some are tasks that have changed in importance since entered on the program. Others are things that have been done or handled by someone else in the firm.

Naturally, this does not mean to go over the daily work schedule and delete all things that can't be referred or deferred. It might be the easy way to clear the desk, but it is not typical of a successful top level executive.

Minor and unimportant things on a daily schedule got there for some reason. A quick review of the reasons and recent developments will indicate which items should be deleted.

For instance, a management consultant discovered that one executive was always loaded down with work. His office secretary wrote more letters than any other in the firm. Yet, this executive always had some odds and ends of unfinished business at the end of the day.

Analysis revealed that this executive personally answered all letters addressed to him. Even direct mail advertising with his name filled in on a form letter got an answer. When "file 13" was used to delete these irrelevant and unimportant letters, this executive's efficiency increased.

DO

Fifteen minutes spent in an analysis of the daily work schedule and the application of the REFER — DEFER — DELETE formula will be a quarter-hour well spent. Now, the petroleum executive's calendar will be reduced to a reasonable day's work . . . a plan that can be done in a minimum of time and with professional executive skill. ★ ★

INDUSTRY SAYS GET ALONG WITH PEOPLE

Ken Hand

IN THE MAD JUNGLE of business competition there stalk certain cynics who will tell you that there is a basic conflict between being a regular guy and getting ahead.

They may have a point. The jury is still out. This school of thought is anchored to the premise that corporation presidents are quick to discover latent talents in a new employee whose uncle is chairman of the board.

But another theory is this:

Far, far better than genius or merely talent is the ability to get along with people. That attribute is worth its weight in rich in-laws. Bu$ine$$ courte$y — that's the way to promotion and pay.

I am picking no win, place or show positions in this think derby. I would like only to suggest that in a lot of offices there are a few people who are not worth getting along with.

The few:

The laughing stool pigeon.

This type is found in both sexes, but primarily among men. Not a vicious type by intent, perhaps, but, remember that a small boy with a loaded gun and no motive will shoot you just as dead.

Modus operandi of the laughter goes like this:

He stands in the middle of a quiet office and roars, "Ho-ho-ho, you sure tied one on last night and who wuz that blonde you wuz with?"

The guy in the know.

This not-rare-enough species adopts a knowing air from what lets you know comes straight from the horse's mouth during a conference with high brass. The truth is, he heard it from a third assistant straw boss who got it straight from the lips of the janitor.

The joker.

You know him. He orders a carload of hay sent to a fellow worker's apartment during his mother-in-law's visit. But play the most harmless prank on him and he blows his top. The sensitive type!

The majordomo of the water cooler.

He's got all the dirt on everybody, a complete file with names, dates and places—inside, confidential stuff about high jinks in high places. Shun him.

The mumbler.

Take letter sixty-four, and respectfully yours, that's the invoice, etc., and g'bye. Nobody knows what in thunder he wants done and if you ask him, he can only thunder back.

The heartbreaker.

No brains, even fewer principles but just what the women have been waiting for. But women are not that stupid.

The conferencier. Good in a conference, but not much help in a pinch. If he had a family crest, it would be crossed razors.

The dispenser of qualified compliments. They ought to start a club for people who are damned with faint praise.

"He's a good fellow," he begins, but adds quickly, "but he used to be pretty wild." "He's a good fellow — but he's got a great aunt who dips snuff."

The respectful suggester.

Begins all inter-office memoranda with "I respectfully suggest." What he really means is "Listen, Knucklehead . . ."

The heir apparent.

This clown prince of the office hasn't studied his job, but he's studied the boss. Fast on his feet, too. Surprising the boss taking surreptitious peeks at the daily racing form, he says, "Chief, you look tired. You've been working too hard." ★ ★ ★

Mr. Hand is Business Editor of The Dallas (Texas) Morning News; the article is reprinted from that publication.

Attitude Rates Merit

While *productivity* measures an employee's *direct* contribution to production, *attitude* measures his *indirect* contribution.

Each of us influences, to some degree, everyone with whom we come in contact. This influence can be either constructive or adverse. If the influence is constructive we stimulate others in both attitude and performance, and, of course, if the influence is adverse, the opposite is true.

Attitude is not the same as personality. Some people are quiet by nature, some are shy, others are gregarious. This is not attitude. Any one of these types can be either friendly or unfriendly, cheerful or dour, cooperative or unwilling. In other words one's effect on others can be either positive or negative regardless of his basic personality type. *From At Home At Easthome, company publication of Easthome Furniture Industries, Lancaster, Pennsylvania.*

★ *Keep your fears to yourself and share your courage with others.*

Unseen Labor Costs

A recent survey made by the Automotive Parts Manufacturers Association, revealed that companies in that industry gave employees fringe benefits which averaged 51.56 cents for every hour worked in 1957. This cost compared with 14.42 cents 10 years ago.

The survey revealed that the most expensive cost item among the fringe benefits was vacation pay, which cost the industry an average of close to 12 cents per man-hour worked. Next, was the cost of pensions, which averaged 10.72 cents an hour. Holiday pay averaged 6.24 cents. (BNA; Collective Bargaining.)

It is reported that the Chrysler Corporation over the past three years has spent over $6,000,000 in pay to union representatives for time off the job. Management should review carefully and constantly the extent and costs of grievance handling and attempt to keep these costs at a minimum. (BNA; Labor Policy and Practice.)

★ *Good examples have twice the value of good advice.*

Business-Gov't-Public Relations

Although the well being of business and welfare of all citizens are tied closely together, business and government sometimes work at cross purposes, Clifton W. Phalen, executive vice president of AT&T declared in a speech before the National Petroleum Association. He cited three specific examples of conflict—government pressure to drive earnings down, high taxes, and lack of sufficient freedom to change, to improve, and to progress with the times. He suggested four points on which to work toward better understanding:

1. We must do our jobs as well as we possibly can, for here begins public confidence and trust, or distrust and suspicion.
2. We must do a better public relations job, to get better public understanding of our objectives, accomplishments, and problems.
3. Businesses must learn to understand each other's problems, for if we don't, then we are only asking for more control, more regulation, and more interference of all kinds.
4. We have got to do a better job of giving government people real insight into business needs and business development.

Strange Ways

As Warner & Swasey has stated in an ad in *U.S. News & World Report:*

"THERE'S NOBODY HERE BUT US CHICKENS" AND WE'RE GETTING MIGHTY CONFUSED

In the last 3 years six different agencies of the federal government lent 35 million dollars to encourage increased poultry production.

A seventh government agency is spending 12 million dollars to buy surplus eggs to remove them from an oversupplied market.

★ *Business is really more agreeable than pleasure; it interests the whole mind, the aggregate nature of man more continuously and more deeply. But it does not look as if it did.*

—Walter Bagehot

2800 Boys Have Vacation

There are no oil fields in the High Sierra of California.

But this summer—thanks to the oil industry—some 500 underprivileged but deserving boys are learning to become good citizens in a remote camp in the Sierra wilderness.

The isolated mountain retreat is the R. M. Pyles Camp, a cooperative effort of oil men. It was established 10 years ago for 12 to 16-year-olds from unfavorable environments who could benefit from two weeks of outdoor life in the mountains.

Since its establishment more than 2800 boys have spent two week stretches in the camp, fished its streams, ridden

R. M. Pyles, at right, talks over the boys camp named in his honor with three youths who enjoyed two weeks at the mountain camp.

horseback on surrounding ridges, swam in cool mountain pools nearby, and learned about nature in the great classrooms of the outdoors.

The youths are selected by local juvenile authorities with the cooperation of educators, recreation directors and social workers. All expenses including transportation, food and camping equipment are provided by oilmen.

The oilmen banded together in 1949 to establish the camp as a tribute to fellow oilman R. M. "Bob" Pyles who long had dreamed of a youth camp where the underprivileged could learn to become good citizens. Pyles, general superintendent of Southwest Exploration Company, had helped many of his cohorts weather the depression years and the camp was their way of expressing gratitude.

PROBLEM: More Propane for Caracas

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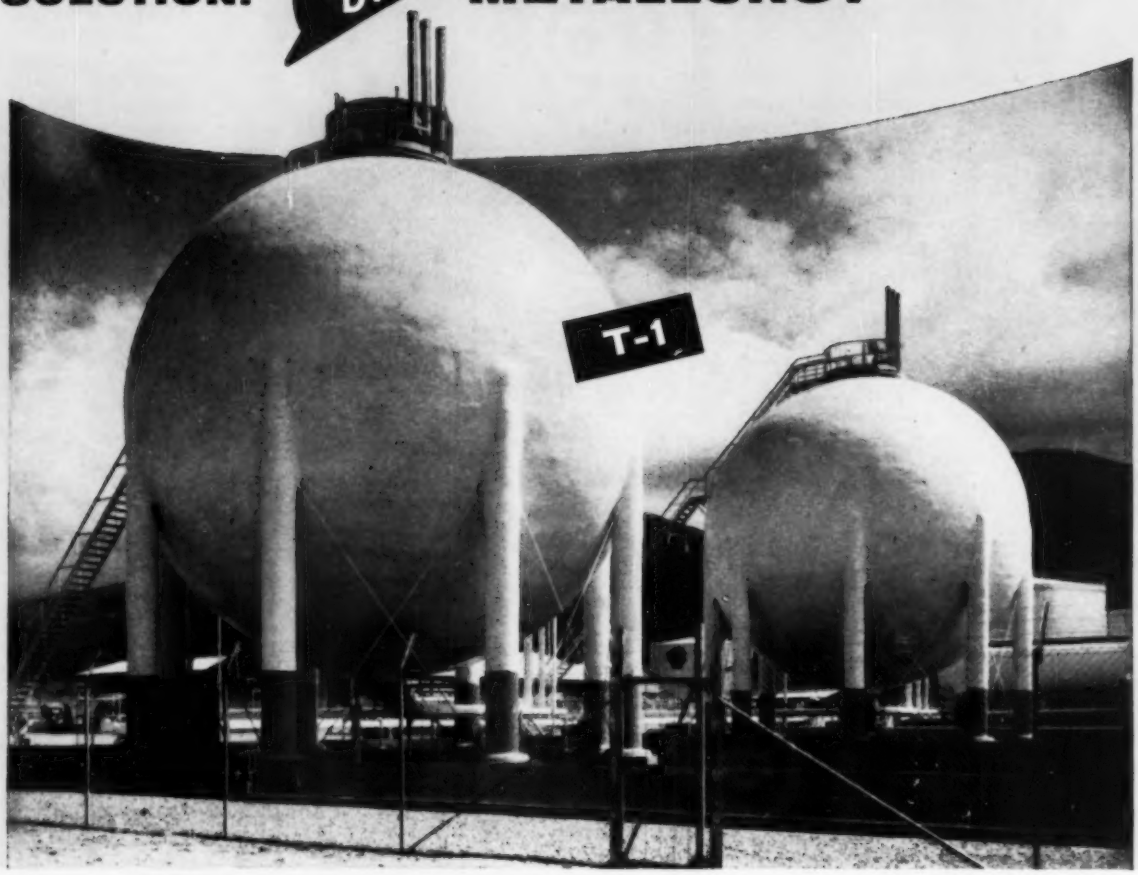

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2 HORTONSPHERES—Propane Storage

Compania Shell de Venezuela Ltd.

Capacity: 6,900-bbl. each

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Steel: T-1

Diam: 42-ft.

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Stress relieved in field

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Hydrostatic test: 354 lbs. sq. in. (at top of vessel)

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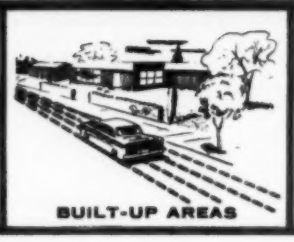
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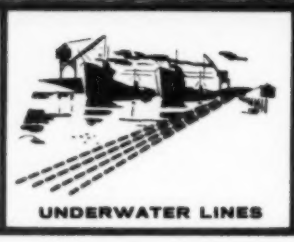
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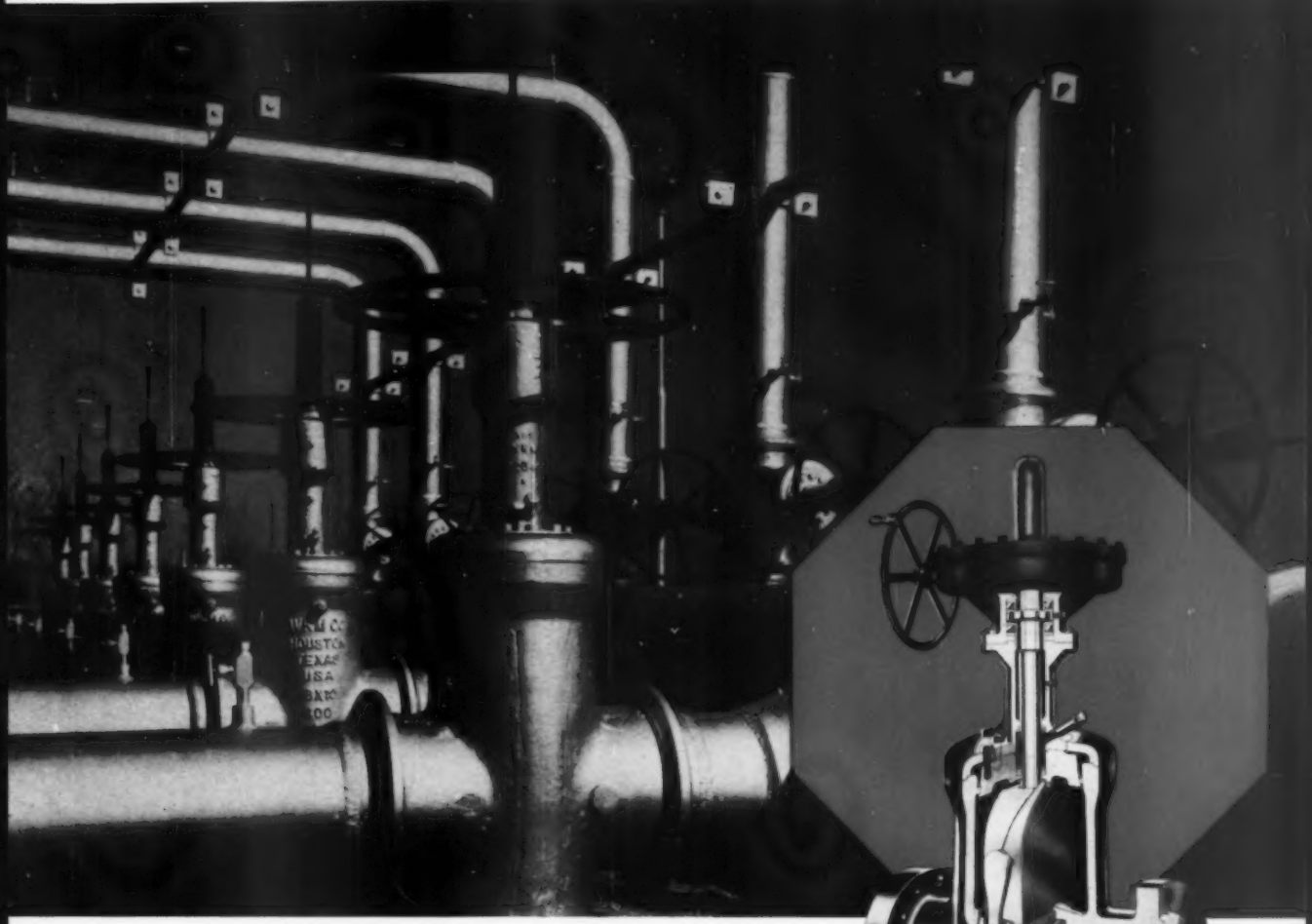

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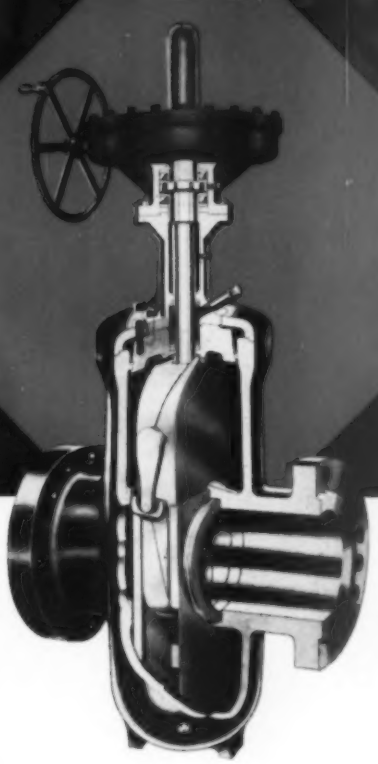

W-K-M's creative engineering process begins with your problems: design, production and field service are based on your needs. That's why W-K-M's ASA Gate Valves set the standards on pipelines throughout the world.

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For complete dependability and long-range economy, specify W-K-M ASA Gate Valves—they're the answer to all your pipeline valve problems.

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This W-K-M ASA Gate Valve is typical of W-K-M's superior design, painstaking production, and thorough testing.

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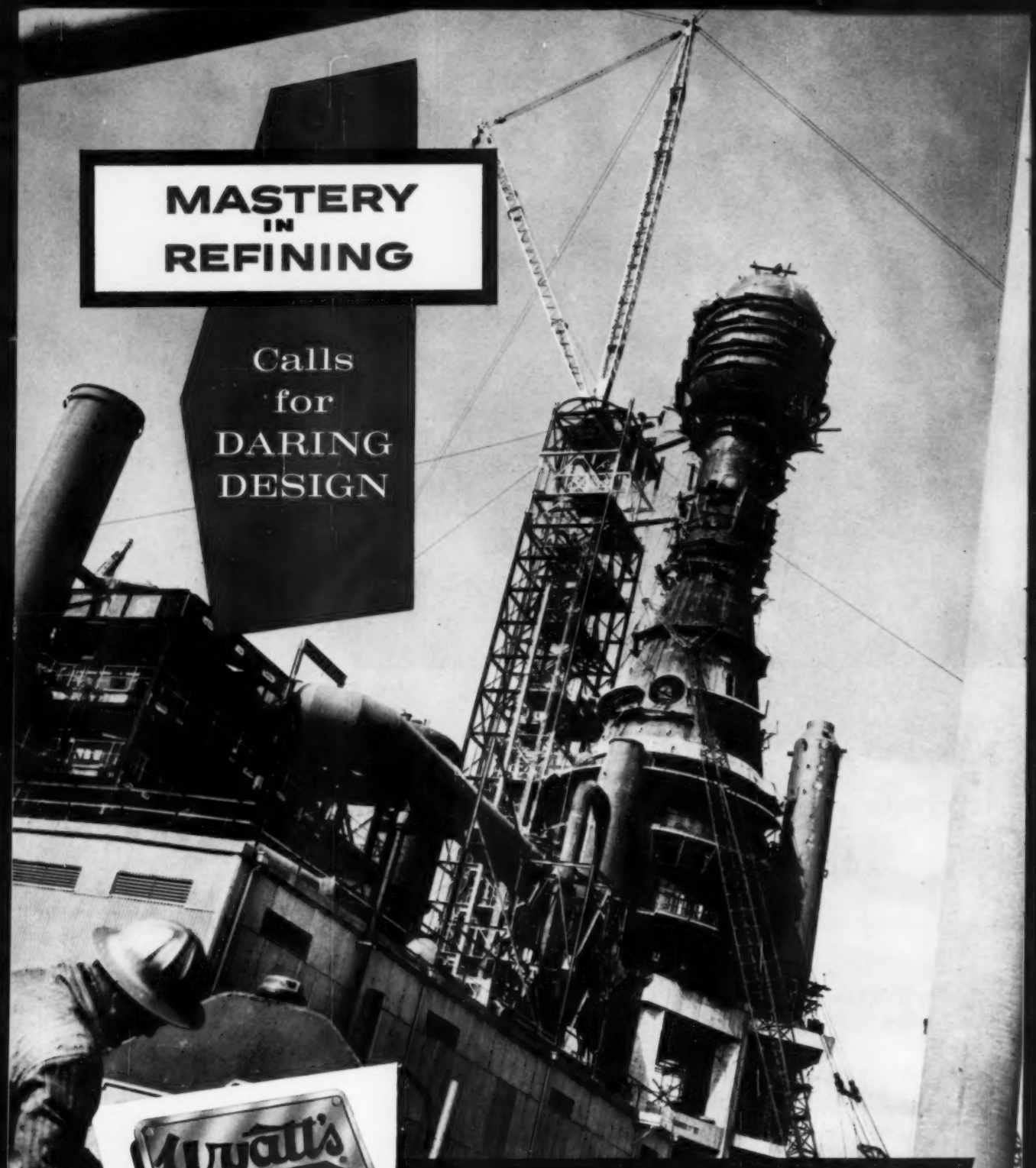

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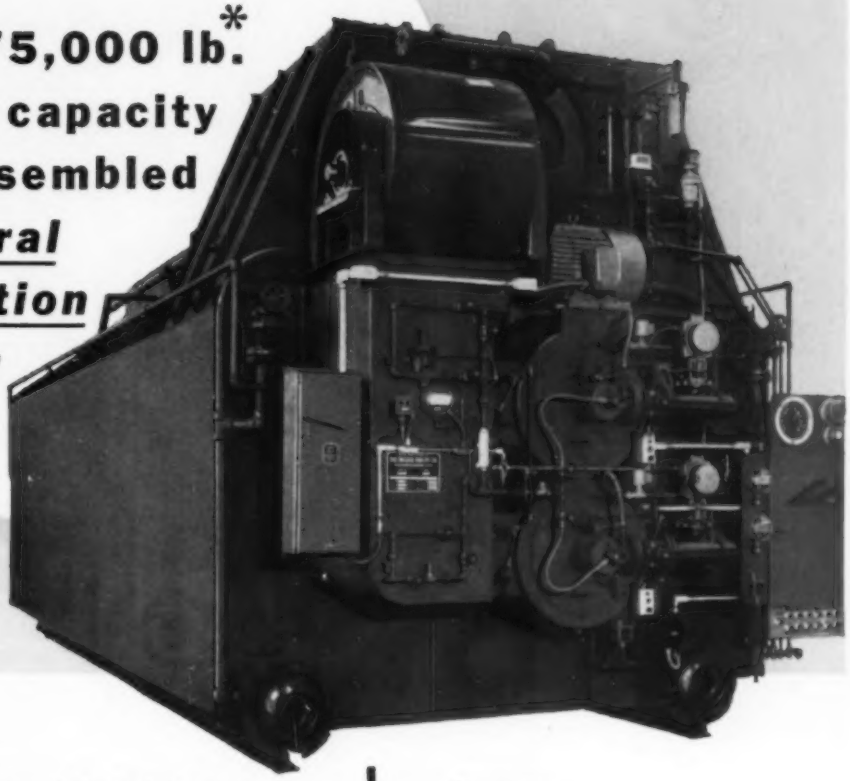

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169

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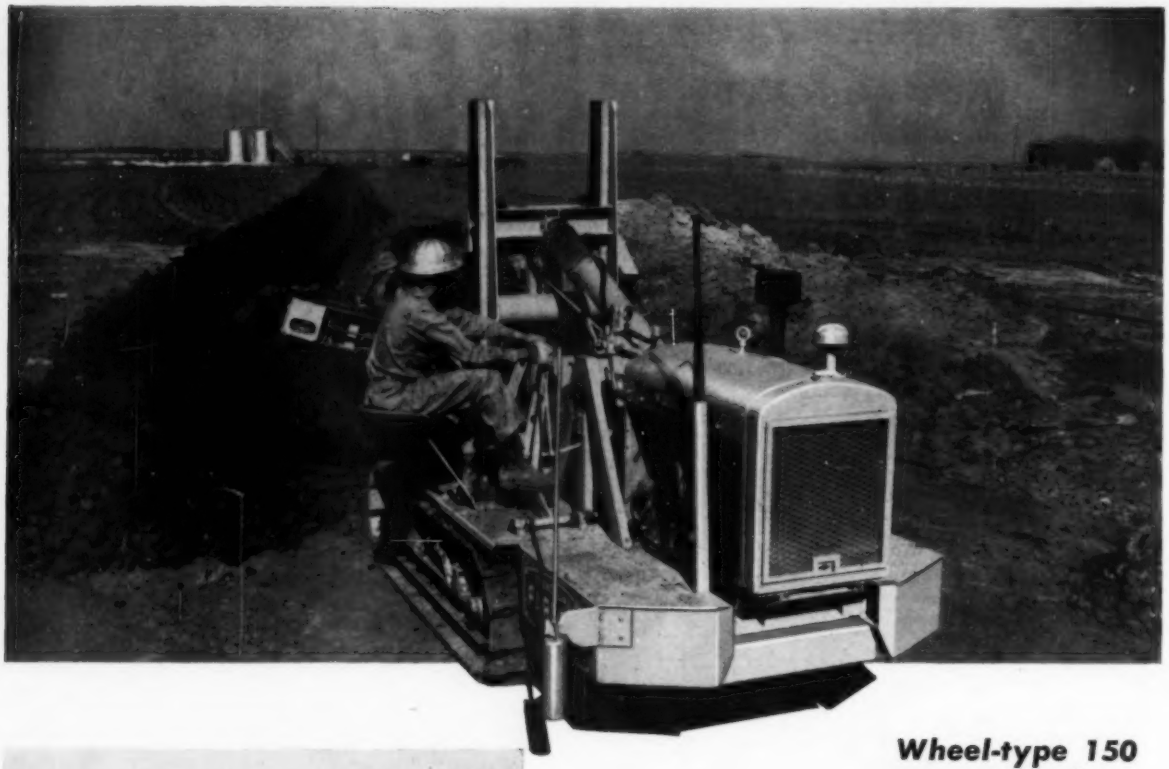

Need a good, small, ladder-type trencher? Then meet the Parsons 77. It's just 3 ft.-8 in. wide — and 5 ft.-8 in. "low". Weighs only 6700 lbs. Small in size but big in capacity, the 77 digs up to 21 lineal ft. of trench per minute, 6 to 18 in. wide, at depths to 5 ft. Big Parsons line offers you a complete selection of heavy-duty ladder and wheel-type machines for opening any size trench — from 6 inches to 6 feet wide — and up to 19 feet deep.

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Wheel-type 150 opens trench 16 to 26 in. wide

There is no need to dig and backfill excess yardages on feeder lines, laterals, gathering systems, etc. This medium-size wheel-type Trenchliner fills the bill on secondary lines — and has ample work range to handle a good share of your main-line trenching, too. You get cutting widths from 16 to 26 inches, depths to 5¾ feet with the Parsons 150. What's more, 30 digging speeds from 12 inches to 25 lineal feet per minute assure maximum production at every depth, width, in all soil conditions. A hydraulic ram on vertical mast raises and lowers the digging wheel — gives infinite depth selections, maintains close grade tolerance even in toughest digging. A separate hydraulic ram tilts the mast, balances weight of wheel forward when traveling or trailer loading.

Heavy-duty wheel takes cast-steel buckets with self-sharpening, reversible "Tap-In" teeth, or quick-change gumbo buckets. Shiftable, reversible belt conveyor discharges spoil on either side. 16-inch crawlers, grouser-type shoes, provide plenty of digging traction for cross-country work. See Parsons distributor, or write for 150 literature.

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MIDEAST OIL VITAL TO ITALY

Although Italian production is increasing (mostly in Sicily where private companies are allowed concessions) great demand of refineries is met most efficiently by Mideast crude...The country would be struck a hard economic blow if political troubles limited exports from Middle East area . . .

Simplest solution for government would be to follow Sicily's oil laws, opening concessions to outside capital . . . High taxes make gasoline and diesel oils a costly item for the average customer . . . Motor gasoline is 91 cents a gallon . . . 68 cents of it for taxes

Dr. E. G. Nottes

ITALY, perhaps more than any other country in Western Europe, will be hurt by deterioration of the Middle East situation.

Most crude oil supplies for Italy's giant refining industry come from the Mideast area. This not only fills a growing domestic demand but permits products to be exported to Europe, Africa, and the Middle East at the rate of more than 100,000 bbl per day.

Within the last year Italy has pulled ahead of France in refining capacity. Only the United Kingdom has more than the 702,100 bbl per day reported by Italy in Western Europe. France is now third with some 650,000 bbl per day capacity.

Production is a different story. Italy alone produces about 2900 bbl per day outside of Sicily, which has its own more favorable laws for oil exploration. Sicily has increased its production to 22,900 bbl per day since the first commercial find by Gulf Oil in 1953.

France, with more inviting petroleum laws, has within the last several years raised its production to some 28,000 bbl per day after the Esso Parentis discovery in 1954. With present extensive exploration activities, rate of discovery should be on the increase. West Germany and Austria have also made great strides in their industries since World War II although conditions in Austria were very unfavorable.

The Author

Ernest G. Nottes, Fellow Institute Petroleum (London), graduated in chemical engineering from the Technical University, Vienna, where he received his Doctor of Science degree in 1935. He was for years in synthetic fuels and the petrochemical development and production departments of the former I. G. Farben Leuna plants and Bayer-Leverkusen works.

When visiting the "Continent Down Under" after the war he was appointed refinery superintendent of National Oil Pty's shale oil cracking plant and refinery at Glen Davis, Australia.

Upon his return to Europe he rejoined former I. G.'s "Badische Anilin and Sodafabrik, Ludwigshafen/Rhine where he is working with the development and technical service department in the petroleum chemicals and additives division. This gives him the opportunity to travel and to visit plants and oil fields.

He also writes occasionally for technical journals and has already contributed several articles published in THE PETROLEUM ENGINEER.

The effect on Italian economy of a shut-off of Mideast crudes would mean proration of growing demand. Italy's consumption of oil products has more than doubled since 1949 and is now 226,000 bbl per day. Consumption of natural gas has risen even more rapidly. The 176 billion cu ft used in 1957 is 20 times the consumption in 1949.

Private enterprise has developed most of Italy's crude oil production. Largest volume was obtained through American enterprises in Sicily. Development and production of natural gas, however, were achieved by state enterprise in northern Italy.

What are the prospects of substantial oil production in Italy? We do know it can be and has been found. Exploration, it may be shown, is limited more by laws than by geology. In 1955 Petrosud (Gulf Oil in association with Montecatini, Italy's largest national chemical combine) made a significant discovery at Alanno near Pescara on the Adriatic Coast. In 1957 Gulf cleared out after Petrosud spent some $4 million because the new oil laws that year created advantages only for Ente Nazionale Idrocarburi (ENI, the Italian state-owned corporation). Montecatini now controls Petrosud. Before the new oil laws, several other foreign companies had asked for concessions, among them Esso, Shell, and British Petroleum. It is unlikely now, however, that any private companies will be active so long as the oil laws remain unaltered.

Geology

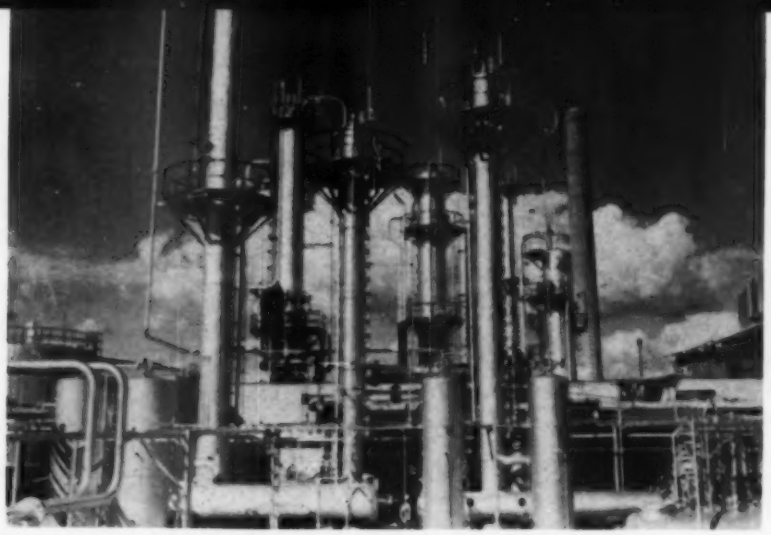
A brief glimpse of the geology picture shows us that the Italian Peninsula is, geologically speaking, very young. Tectonic disturbances are still occurring today and they are connected

ITALY AND ISLANDS

This shows the principal areas of refining in the European country with the largest capacity. Most of the plants are in industrial North Italy. Sicily's refining capacity is growing with the increase in production. The map reveals Italy's constant need for huge crude imports — most efficiently provided by the Middle East.

Largest oil fields are in Sicily but prospects are good for oil in northern areas where principal gas fields are located and on East Coast.

Oil laws are similar in Sicily and Sardinia. Italy has restrictive laws that discourage foreign investment in national oil and gas concessions.



Towers in gas section of Lombarda Petroli refinery at Villasanta, near Monza, Italy. This privately owned Italian company has developed its plant from a very small topping unit to a 5500 bbl a day refinery. (Courtesy Lombarda Petroli)

with some volcanism in certain parts of the country.

Beginning with northern Italy the main ridges of the Central European Alps protect the country to the north. The Italian Alps are built up of crystalline plutonic rocks and slates and there are also mighty limestone formations.

TABLE 1. — Italian Refineries

Name of company	Plant location	Crude Capacity B/D
Anonima Petroli Italiana	Falconara	26,000
ABCD	Ragusa, Sicily	100
AGIP-Mineraria	Cortemaggiore	3,000
AGIP	Gela, Sicily	3,000
Aquila	Trieste	26,000
Bianchi Petroli	Cologno Monzese	1,500
Condor S P A	Rho	45,000
Delle Piane	Genoa	1,000
DICA	Carrara	9,200
FIAT	Torino	lube oils
Garrone	Genoa	29,000
Golfo	Gaeta	20,000
IROM	Marghera, Venice	35,000
IPLOM	Busalla, Genoa	4,000
ICIP	Mantua	20,000
ILSEA	Valmadrera, Como	2,700
Italia SPA	Cremona	25,000
INPET-Shell	La Spezia	35,000
Lombarda Petroli	Milan	10,000
NILO	Milan	5,500
Petroli d' Italia	Fiorenzuola d' Arda, Parma	4,000
Purfina Italiana	Florence	4,400
	Genoa	11,000
	Milan	7,000
	Rome	11,000
RASIOM	Augusta, Sicily	95,000
ROL	Viguzzolo, Alessandria	1,400
ROMSA	Marghera, Venice	lube oils
Mobil Oil Italiana	Naples	65,000
San Quirico	Genoa	4,500
SAROM	Ravenna	48,000
SARPOM	Trecate, Novara	25,000
SARN	Novara	1,500
SPI	Fornovo, Parma	2,200
Stanic	Bari	47,000
	Leghorn	50,000
Standard-ESSO	Trieste	6,100
STOI	Florence	15,000
Voloato	Milan	3,000
TOTAL		702,100

South of the Alps the Po Valley, some 300 miles in length and between 60 and 100 miles wide, is very important to the gas and oil geologist. It is made up of a series of Quaternary, Tertiary, and Mesozoic sediments.

The Apennine Mountains run almost 1000 miles through the Italian Peninsula from the Gulf of Genoa. The uninterrupted chain of mountains is like a mammalian backbone. The Apennines were folded up in the middle Tertiary period; it is composed of Mesozoic limestones, dolomites, sandstones, marl, clay and gypsum in the north, having interspersed gabbro and serpentine lodes, whereas in the south in Calabria the archaic ground rocks are becoming predominant.

The large island of Sicily is mountainous in the northern part, limestone of old Tertiary age prevailing. The southern part of the island shows much young Tertiary formations interspersed with volcanic rocks. In the eastern part we find volcanic rocks around the large area of Mt. Etna (nearly 10,000 ft).

Sardinia, another large island, is covered mostly by mountains. Geologically speaking, it is similar to the Apennine region of Middle Italy. Sardinia has some coal deposits.

Exploration

Owing to intensive exploration work the last few years, the tectonic and stratigraphic conditions in the underground of the Po Valley (northern Italy) are now known pretty well. The youngest sediments (Quaternary and Pliocene) are very large southward of the River Po, especially between Piacenza and Ravenna. (See map of Italy.) These sediments have in some parts a thickness of 15,000 to 18,000 ft.

In the range of the thickest sediments are found anticlinal structures with the most productive gas deposits. Drilling has gone down to 12,000 ft but hitherto gas has been found only in the earlier formations.

At 5251 meters (approximately 16,000 ft) the oil company "AGIP Mineraria" claimed to have the deepest hole in Europe at Piadena in the Po region. The hole was intended to find the lowest extension of the Miocene strata.

Drilling equipment in this case as in many other parts of Italy is up-to-date. An Ideco drilling rig was used at Piadena. The rig was built in Italy under license by an Italian factory.

Sicily's Oil Industry

As an independent region, Sicily has its own oil laws, which favor investment of foreign capital as well as the state monopoly, ENI. This open-door policy results in a great deal of exploration and activity in the island by a number of companies—both domestic and foreign.

Production of oil began on a commercial scale in 1953, when Gulf Italia opened up the famous Ragusa field. The field produces more than all others. Gulf Italia produced in 1957 about 7,420,000 bbl. The trend is toward an increase in production to about 11 million bbl a year.

Quite recently AGIP Mineraria (majority owned by ENI) found oil near Gela in the south of Sicily. Production there jumped rapidly to approximately 1,875,000 bbl annum.

British Petroleum interests discovered some oil near Vittoria, in eastern

A deep ravine or gulch, common in some parts of the town of Ragusa, Sicily. A well is being pumped at the bottom of the canyon. Limestone caves in the walls provide cool housing during hot Sicilian summers.

New Gela field in Sicily, owned by AGIP (government company) is second largest field. Ragusa is first. In background is drilling rig and storage tanks.

Sicily, but production is not commercial. Some enterprises in which Gulf Oil, Esso, RASIOM, Montecatini, Edison, ENI and others are participating are exploring the island.

Sicily's crude oil is of an asphalt-base type and suitable for the production of road building materials.

Most oil from Ragusa field is pumped through a 14-in. pipeline over a distance of 40 miles to Pensiola Magnesa where Gulf has constructed an oil loading terminal and to the RASIOM refinery in Augusta on the southeastern coast of the island (see map). AGIP is planning to construct a pipeline to transport crude from the Gela field to Gela harbor where a small refinery already in operation, will be enlarged.

RASIOM refinery is one of the larger ones of Italy and the biggest in Sicily. Originally a small unit, imported from Texas, it has increased its throughput of crude to 55,000 bbl per day. Ideally situated near the main tanker routes from the Middle East, it processes imported crude oils as well as domestic output. Large harbor facilities at Augusta complete the installation.

Natural Gas Industry

The state-owned ENI has done a competent job of developing natural gas, judging from results. As we have already mentioned, between 1949 and 1957 consumption rose from 8.8 to 176.7 billion cu ft per year. There is a large and extensive distribution pipeline network for natural gas, especially in northern Italy where about 70 percent of the industrial potential of the country is concentrated. All this area is under the ENI concession. Not only natural gas but some crude oil is produced.

Refining

The state entity has also a large share in Italy's refining capacity and is building an increasing number of service stations. Some larger refineries in Italy are also operated by companies owned jointly by private companies and by ENI through subsidiaries. Among them are Esso and British Petroleum, which besides having joint companies with ENI also own refineries individually.

A considerable amount of Italy's production of gasolines, gas oils, fuel oil, etc., is processed and sold by companies whose majority stock is held by private Italian capital. Among them are Raffineria Italia-Cremona, Dott. Eduardo Garrone-Genoa, ICIP-Mantua, SAROM-Ravenna, Lombarda Petroli-Villa Santa, Raffineria Golfo-Gaeta.

In Sicily two large petrochemical works are under construction by Sicedison and Montecatini, not far from Augusta. At Ragusa a petrochemical plant owned by Raffineria Asphalti is under construction. Some crude oil from the nearby Ragusa fields can be used there. A small local refinery is already onstream.

What of the Future?

As we have said, the future of Italy's oil activities is tied up with Mideast oil. Montecatini and ENI are exploring for oil in northern Italy. Adriatic Petroleum (Cities Service) has exploration permits in southeastern Italy and is going to do some geological work. There is, however, no all-out effort, which is vitally needed to gain some security of supply.

The present situation favors Italy and its refining industry owing to its location on the route of tankers from the Middle East, putting Italy in a fortunate competitive position because of this transport situation and because of its many modern refineries.

The petroleum industry has helped the Italian economy but not so much as it might have if taxes were less burdensome. The cost of fuel energy in the country shifts too great a dependence on inefficient human energy to produce the needs of the country.

Gasoline prices at the filling station are much higher than in most other countries of the world. Practically ¾ of the gasoline price is taxes collected by the ministry of finances. The price of 1 liter normal gasoline (3.8 liter = 1 U.S. gal) is 142 Italian lire (24 cents). This would be equal to 91 cents for a U.S. gallon. Tourists and foreign visitors, however, can obtain so called "coupons" when crossing the Italian border to an amount of 30 liters* per day with a certain reduction in the price.

Diesel fuel will cost in Central Italy around 55 cents a gal, which includes 57 lire or 37 cents for taxes.

Fuel oils have to bear a tax of about 22 percent. It is interesting to note that coal is free of taxes. Owing to favorable and cheap prices of U.S. American coal and cheap freight rates in the Atlantic traffic this American coal is on a very competitive basis now.

In a future European common market Italy's oil and natural gas industries will be in a fortunate competitive position because of modern refineries, petrochemical plants, and favorable transport situation. Large harbors and terminals including excellent research facilities will contribute to efficient operations that produce cheap energy.

In order to compete from a price point of view, however, the heavy taxes on products will have to be reduced if Italy intends to compete successfully with other countries of the common European market. It is difficult to understand the reasoning that denies its own people benefit of cheap energy by tax burdens that seem to defeat their own purpose.

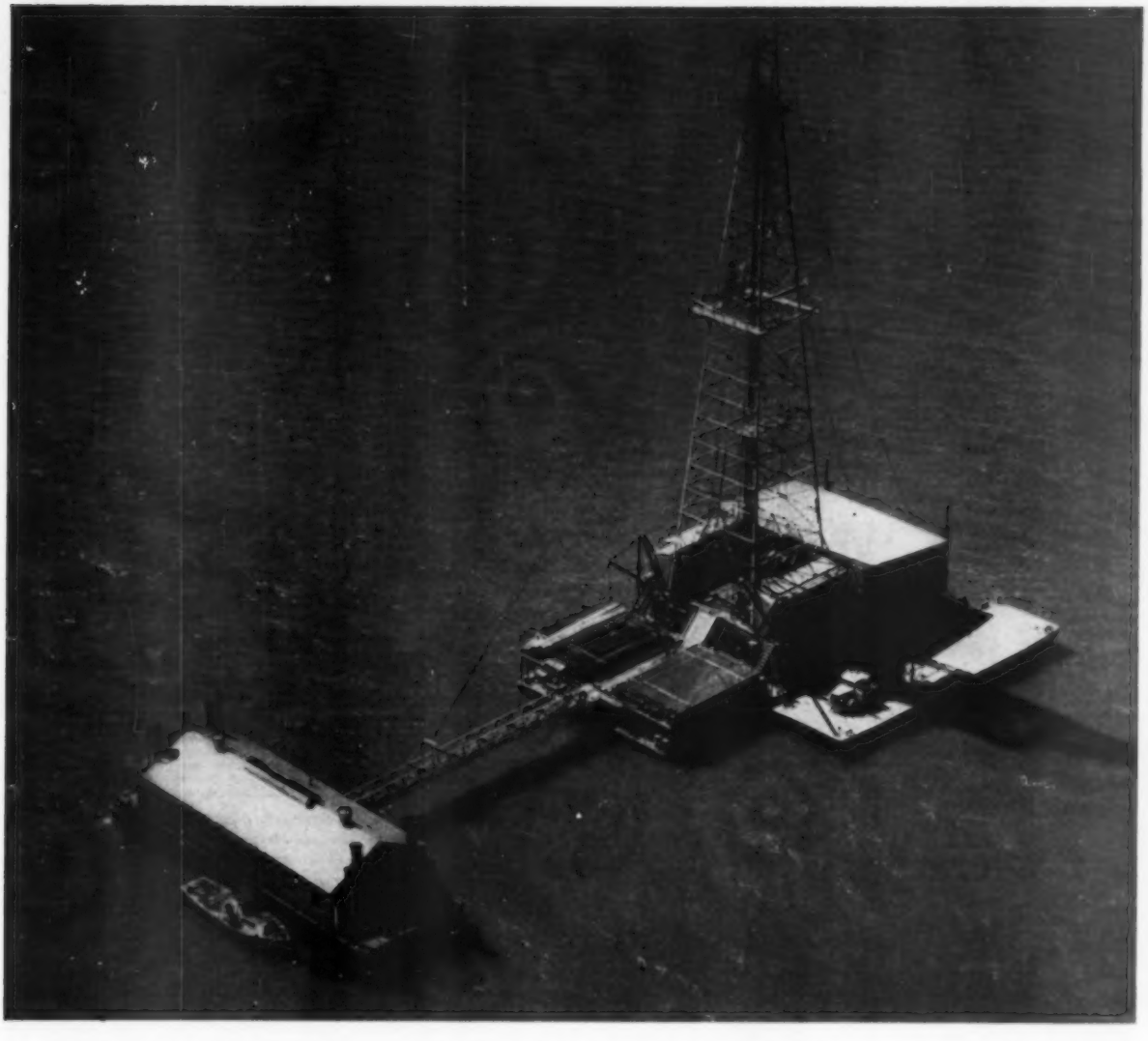
There appears to be nothing in the immediate future that would assure Italy of crude supplies without the volatile Mideast, but it is obvious that if the country wants to increase its mainland reserves, it will offer opportunity for capital so that a thorough exploration program can be financed.

There are two prime hazards to be removed if Italy's petroleum industry is to advance soundly: One is to make a drastic cut in taxes on oil products to its citizens and the other is to adopt an open-door policy for finding and developing its petroleum resources.

*Approximately 8 U. S. gal. ★ ★ ★

TABLE 2. — New Petrochemical Works.

ABCD	Ragusa—Sicily	Approximately 5,000 ton/yr Polyethylene
ANIC	Ravenna—Mainland	" 50,000 ton/yr SBR rubber
		" 750,000 ton/yr Ammonia
		" 74,000 ton/yr Styrene
		" 40,000 ton/yr Butadiene
Montecatini	Ferrara—Mainland	Polyethylene and glycols, ethylene oxide
Sic Edison	Mantua—Mainland	Olefins, steam cracking, styrene, polystyrene, propylene, tetramer.



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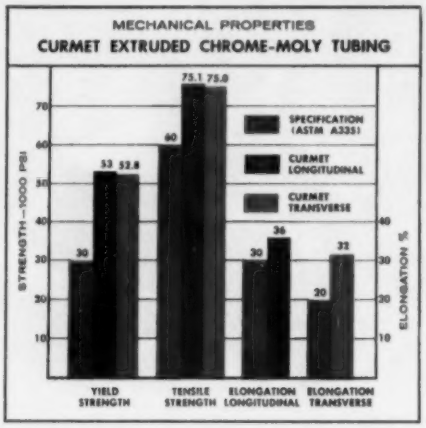
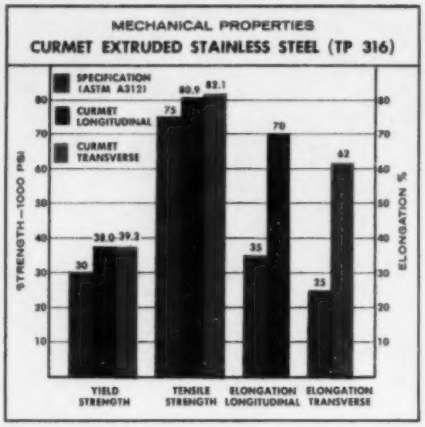
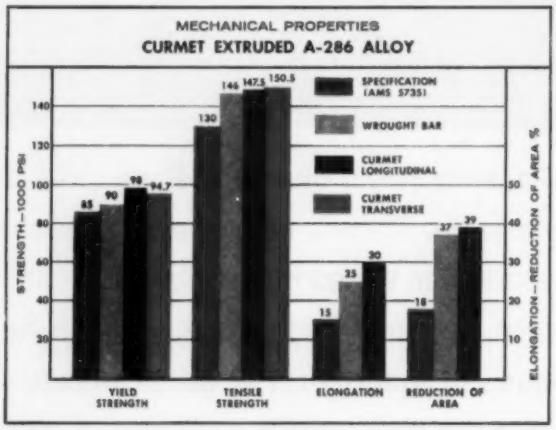


Made by conventional methods, tubing of this alloy would normally show a transverse strength 10 to 30 per cent below its longitudinal strength.



All properties of this CurmeT processed product prove to be not only well above specification, but *both* transverse and longitudinal strengths exceed the conventionally wrought product.



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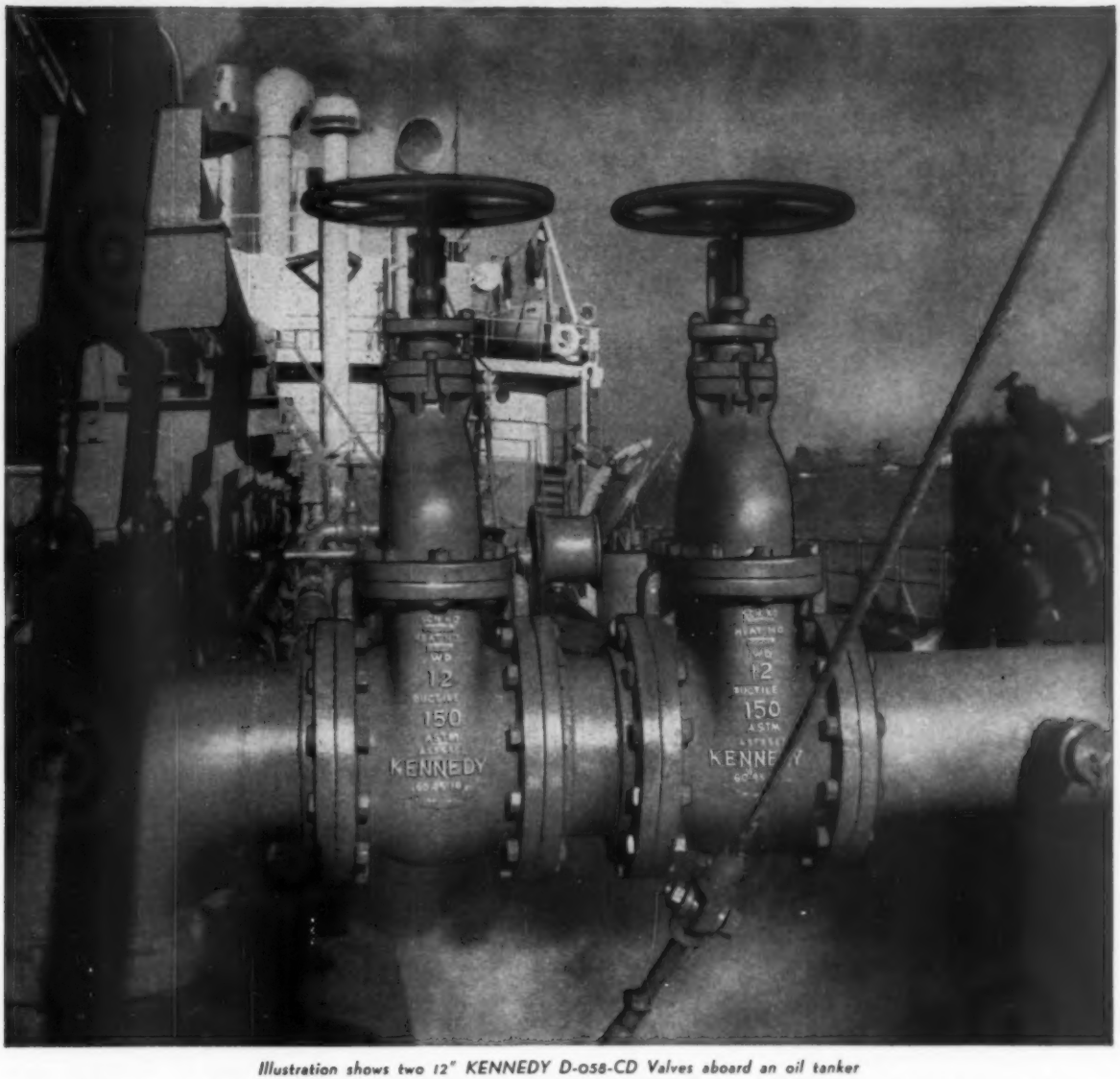

Illustration shows two 12" KENNEDY D-058-CD Valves aboard an oil tanker

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Management Personals

John E. Roth was elected a director and senior vice president of Tidewater Oil Company. Prior to his election, Roth had served as administrative vice president for production, in charge of coordinating Tidewater's domestic and foreign exploration and production activities.

J. E. Roth

C. A. Setterstrom

Carl A. Setterstrom has joined Sun Oil Company's research and development division as assistant director—commercial development. During the past three years Setterstrom has been special projects manager for Chas. Pfizer & Co., Inc. Earlier he had been general manager for the textile fibers department at Union Carbide Corporation.

W. Joseph Straus was elected to the board of directors of Britalta Petroleums, Ltd., Canadian independent oil company of Calgary, Alberta. Straus, economist and a financial adviser to **William Rosenwald,** chairman of American Securities Corporation, is also a director of that investment banking firm, and of American Machine and Metals, Inc., Haveg Industries, Inc., Texas Butadiene & Chemical Corp., and other companies.

K. W. Brill was elected vice president of Continental Oil Company. Formerly assistant to the vice president, he will continue headquarters in New York.

D. R. Zachry Sr. has resigned from American Petrofina Company of Texas. Zachry was executive vice president of the southwest subsidiary of American Petrofina, Inc. since the company was formed in July 1957. Prior to that time he was executive vice president of American Liberty Oil Company which American Petrofina acquired in a multi-million dollar purchase in 1957. Zachry stated he needed more time for his private business.

W. L. Williams was named treasurer and assistant secretary, and **B. Z. Kastler Jr.** was named secretary and assistant treasurer of Mountain Fuel Supply Company. Williams had been assistant treasurer and assistant secretary and Kastler, company attorney. **L. Clyde Olpin,** former secretary and treasurer, retired. **John Crawford Jr.,** assistant company attorney, replaces Kastler, however, Kastler will continue to direct the company's legal affairs.

W. B. Cleveland was named to the board of directors of Creole Petroleum Corporation. Cleveland replaces **Dr. W. L. Butte,** who has resigned to accept an appointment as Professor of Law at the University of Texas. Dr. Butte became a member of the Creole Board in 1956 and prior to that had 16 years of service with Jersey Standard and its affiliates. He will remain with Creole as a general executive in Caracas until the end of the year.

George W. Wyckoff, Pittsburgh business and civic leader, was elected to serve as a Gulf Oil Corporation director. **Ralph O. Rhoades,** Gulf director and senior vice president, was elected executive vice president, succeeding **David Proctor,** who was elected chairman of the board, a post that has been vacant since 1957. Wyckoff is currently a governor-vice president of T. Mellon and Sons in Pittsburgh. Rhoades was designated a senior vice president in 1955 and in 1957 was elected a member of the board. Last February Proctor resigned as general counsel to devote more time to his executive vice presidential duties. He is a member of the board of directors of API and the National Petroleum Council.

Two new research scientists of the Ohio Oil Company's Research Center near Denver are **Dr. David Pandres Jr.,** and **Dr. Hendrik K. Van Poollen.**

Dr. Pandres' previous experience includes teaching assistantships at the University of Texas, and electrical engineering positions at Chance Vought Aircraft Company, Dallas, and Brown & Root, Houston.

Dr. Van Poollen's previous experience includes work as a reservoir engineer for Standard Vacuum and research section leader for Halliburton Cementing.

Elected members of the board of directors of Kermac Nuclear Fuels Corp. were **Edwin L. Kennedy,** partner in the investment banking firm of Lehman Brothers, New York, and **Bernard M. Silbert,** president and general counsel of Pacific Uranium Mines Company, Los Angeles. Kennedy is also a director of Kerr-McGee Oil Industries, Inc.; Republic Natural Gas Company; Murphy Corporation; and Independent Petroleum Association of America.

Oscar John Dorwin, formerly vice president and general counsel, was elected senior vice president and continues as general counsel of The Texas Company. He has been a director since 1957. **Marion J. Epley Jr.,** assistant to the chairman, was elected a vice president. **Kerryn King,** formerly general manager of the industrial and public relations department, was elected vice president in charge of that department.

Ray Holland, formerly *Shreveport Times* oil editor, has been named director of the public relations department of Titan-Tex Drilling and Production Company. He was with the *Times* for 4½ years and oil editor for the past year. He will head the department handling public relations for Titan-Tex and affiliated companies.

Gerald McGrew of Bartlesville, Oklahoma, was elected a vice president of Cities Service Oil Company. He steps into the vice presidency from managership of the company's crude oil supply division.

Dee J. Kelly was appointed general counsel for the Moncrief oil interests. He was associated with the Fort Worth law firm of Cantey, Hanger, Johnson, Scarborough & Gooch. Previously, he was one of two legal examiners for the Oil and Gas Division of the Texas Railroad Commission in Austin in 1955 and 1956.

P. T. Bee was named to act in a senior executive position for Murchison Brothers and associated interests. Bee has resigned his position as executive vice president of Delhi-Taylor Oil Corporation.

R. A. "Bud" Darling was appointed vice president of Smithco Engineering, Inc. He will serve as manager and coordinator for all sales activity for the corporation. He formerly served as head of the Darling Company, which he formed.

R. A. Darling

B. S. Smith Jr.

Ben S. Smith Jr. was appointed director of services of Murphy Corporation. He was formerly with Monsanto Chemical Company.

Kerryn King, The Texas Company, was elected chairman of the Committee on Public Affairs of the American Petroleum Institute. King, vice president in charge of industrial and public relations for his company, succeeds **Thomas W. Phelps** of Socony Mobil Oil Company. Phelps resigned from the Committee after he was named manager of his company's economics department.

Stanley D. Breitweiser, vice president of D-X Sunray Oil Company, was elected president of a new state organization to be known as the Oklahoma Petroleum Council, formed at a meeting of the executive committee of the board of directors of the API. Other officers elected were: Vice President, **F. C. Fellingham,** division office manager for Pan American Petroleum, who has been state chairman for the OIC; and secretary-treasurer, **James O. Kemm,** who has been serving as senior district representative for the Kansas-Oklahoma district of the OIC-API.

DEATHS

Paul R. Halbert, 55, president of the Lone Star Pipe Line Constructors, Inc., died September 6 at his home after an extended illness.

Lloyd F. Bayer, senior vice president and director of Tidewater Oil Company died Sptember 29 of a blood ailment.

Lloyd G. Smith, 67, a retired vice president and director of Creole Petroleum Corporation, died September 9 at his home in Pennsylvania of a heart attack.

William Arthur Trout, 72, veteran oilman well known throughout the Southern California petroleum industry, died September 7 following a brief illness. He was formerly vice president and general manager of Emsco Derrick and Equipment Company.

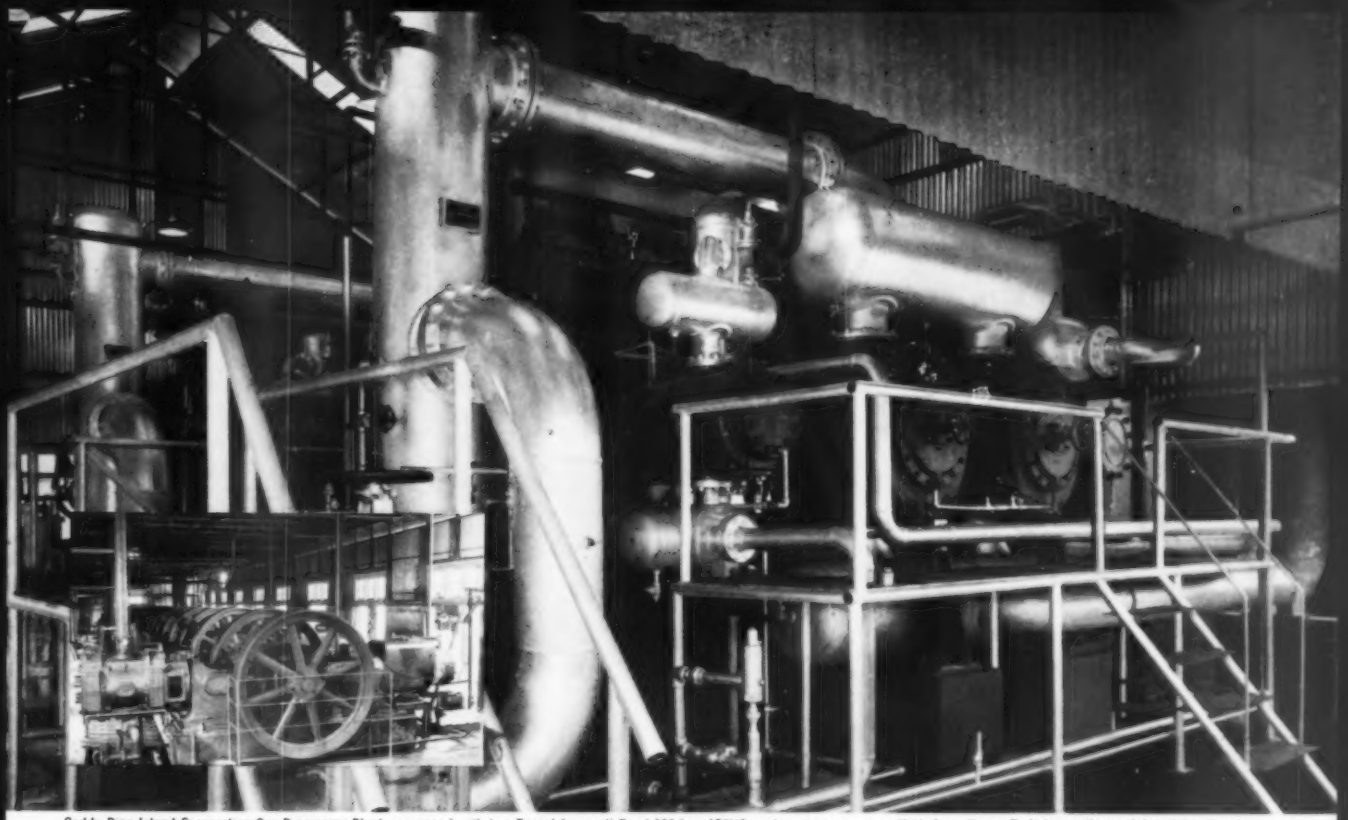
W. C. Windsor Sr., 67, widely known Texas oil executive and civic leader whose business interests also included banking, stock raising, and property development, died September 10.

Ferdinand J. (Ferd) Spang, president of Spang and Company, died suddenly at Cleveland, Ohio, September 10.

Ben H. van der Linden, 78, first exploration and production chief of the Shell companies in this country and world-wide head of production activities for the Royal Dutch-Shell Group until his retirement in 1940, died October 5.

BEAIRD-INGERSOLL-RAND Packaged Compressor Plant

Lowest Cost Per Horsepower Installed



Caddo Pine Island Corporation Gas Processing Plant—equipped with two Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors. Units have Young Radiators with gas, lubricating oil and engine water cooling sections. Other sizes 120 to 660 h.p. Inset picture shows original horizontal compressors.

Two Packaged Compressors

DO WORK OF TWENTY OLDER UNITS

Caddo Pine Island Corporation processes flare gas from 1,000 Pine Island Field wells in an absorption plant located near Oil City, Louisiana. Picking its load up over a thirty mile gathering system, the plant was originally equipped with twenty horizontal compressor units. These have now been replaced by two Beaird-Ingersoll-Rand 12SVG 660 h. p. packaged compressors.

Using three stages of compression the packaged units pull the gas into the plant under ten inches of vacuum. It is then boosted through processing operations and returned for third stage boosting to the sales line. Up to 5¼ million cubic feet can be handled per day with final delivery pressures of 440 psi.

Installation of modern Beaird packaged compressors has increased plant dependability and lowered fuel, labor and maintenance costs. An additional savings will be realized when the field is depleted. Installation of packaged compressors has made the station almost wholly salvable.

Let Beaird engineers help you find an economical solution to your plant expansion or modernization program.

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C. E. Williams, Gulf Sales Engineer, Midland, Texas, and G. W. Ramsey, Assistant Plant Superintendent, inspect force feed lubricators on one of the modern gas engines at the Goldsmith plant of El Paso Natural Gas Company.

No lubrication problems in 8 years of operation

Since 1949, twenty-seven gas engine-compressor units developing 39,985 horsepower at the Goldsmith plant of El Paso Natural Gas Company have been thriving on Gulf Security Oil. Bearing, ring and cylinder wear maintenance records have been excellent.

Insure safe, more effective lubrication protection for *your* compressor units. Specify Gulf Security . . . the high quality, straight mineral oil. For full information, call your nearest Gulf office.

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• News • People — The Trade PARADE

A new source of supply of oil well drilling mud products for Venezuela has been created by Magcobar de Venezuela, C.A., with completion of its new barite processing plant installation at Punta Camacho on the Bolivar Coast of Lake Maracaibo. New plant features a dock facility that extends 2111 ft into Lake Maracaibo to water deep enough to accommodate ocean-going ships that bring the crude ore from worldwide mining operations. The crude ore arrives by ship and is discharged on the longest conveyor belt in Venezuela at the unloading dock (1). It is then moved through the plant to the stockpile (2). After processing, the finished product is often taken to the barge dock (3) for delivery to drilling locations in Lake Maracaibo. The plant office, which houses the two-way radio system, is at left (4).

▸ **C. J. Zabcik** has been named Research and Development Engineer for Baash-Ross Division of Joy Manufacturing Company, at the home office plant in Houston.

DOW CHEMICAL COMPANY announces formation of an overseas subsidiary company in Venezuela to handle its international operations. The wholly-owned subsidiary, Dow Chemical International Limited, S.A., will consolidate overseas sales of Dow products and administer the company's business interests and investments abroad. Dr. Leland I. Doan, president of the parent company, was named chairman of the board and Clayton S. Shoemaker president of the subsidiary. Offices have been opened in Caracas and Robert F. Kincaid, formerly manager of Dow's Montevideo, Uruguay, office was appointed manager.

FORMATION OF THE MARKETING DIVISION of Johnston Testers, Incorporated to handle sales and service of the new sonic pump being manufactured and distributed by the company, has been announced. Offices are at 930 Bank of the Southwest Building, Houston. Charles F. Riker heads the new division as general manager. He was formerly a sales engineer for Johnston. Sales manager for the division is Jack Schuelke, until recently technical editor for *World Oil* magazine.

District sales engineer with headquarters in Houston is W. E. (Bill) Hill. Sonic pump installation engineer for the organization will be Jim Hamilton.

New licensing agreement between Clark Bros. Co., Olean, New York, one of the Dresser Industries, and Armstrong Siddeley Motors Ltd. of England, provides for British manufacture of Clark-designed gas turbines for use in the oil, gas, chemical and process industries in many areas of the world. Attending the signing ceremony in Paris are, left to right: F. T. Blakey, secretary of A.S.M.; H. T. Chapman C.B.E., managing director of A.S.M.; A. Thomas M.B.E., deputy chief engineer and chief designer of A.S.M.; R. R. McCartney, vice president in charge of overseas operations of Clark Bros. Co., U.S.A.; R. Chesneaux, president of Societe Francaise des Industries Dresser S.A.; and M. J. Galpin, manager of Clark Bros. Co., England.

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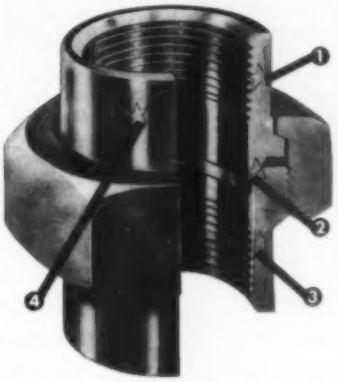
gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 58 showing the complete Catawissa line of Perfect Seal Products.

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. . . featuring convenience, comfort, quality! A cosmopolitan atmosphere in home-like setting. In the center of all downtown activities. Newly decorated. Ultra modern, comfortable guest rooms . . . excellent food at moderate prices in our modern coffee shop and cafeteria.

Radio and Television in room. Air Conditioned rooms in season.

800 ROOMS WITH BATH from $4

GARAGE available at nominal charge. Free overnight parking for registered guests in PARKING LOT.

FAMILY RATES
No Charge for Children 12 and Under —

Harry E. Paulsen, General Manager
FACING GRAND CIRCUS PARK
DETROIT

Trade Parade

Sales Manager Appointed

Claude L. Griffin has been appointed sales manager, United States and Canada, for Security Engineering, manufacturer of rock bits and other oil well drilling tools, with plants in Dallas, Texas, and Whittier, California.

Griffin has been active in the oil industry since 1933. Most recently he was vice president of American Iron and Machine Works Company, in charge of that firm's international sales. His previous service in the drilling and production industries included the designing and marketing of various items of oilfield equipment.

He is active in the affairs of NOMADS, AAODC, API, Shrine, and Jesters. His appointment is part of the reorganization of the sales division of Security, one of the Dresser industries.

▸ **Austin E. Olson** has been named microwave district sales manager on the East Coast for Motorola Communications & Electronics, Inc., a wholly owned subsidiary of Motorola. He succeeds Raymond Kendall who has left the company.

▸ **Lewis C. Black** has been appointed manager of domestic sales by Bucyrus-Erie Company, South Milwaukee, Wisconsin. He had been manager of sales for large excavators since January 1958, and had previously served as assistant general sales manager of large machines and blast hole drills.

▸ **J. E. Watson, Jr.,** former manager of the Miami district of Allis-Chalmers Industries Group, has been appointed manager of the firm's New Orleans district. Watson succeeds **R. F. Muller,** who retired after 38 years of association with the New Orleans district. **W. E. Scott,** former sales representative in the Charlotte district since 1952, becomes manager of the Miami district.

▸ Cardwell Manufacturing Company has named **Richard G. Jones** as sales representative for the South Texas area. He will maintain headquarters in Cardwell executive offices at 2010 South Coast Building, Houston.

▸ **C. J. Wilson,** of Pasadena, California, has joined B-I-F Industries, Inc., Providence, Rhode Island, as an eastern regional engineer. **Henry J. Dumas, Jr.,** of Worcester, Massachussets, has joined the company as a development engineer specializing in automatic control devices.

▸ **Dr. William H. Schuette,** The Dow Chemical Company and general manager of its Midland division, has been elected a company vice president. He will continue his duties as division general manager.

Incumbent officers and members of the executive and finance committees were re-elected by the board.

G. J. Williams has been named to succeed **Donald L. Gibb** as sales manager of Dow Chemical's plastics department.

▸ **John S. Kline** has been appointed assistant general manager and chief executive of The Carpenter Steel Company's Alloy Tube Division, Union, New Jersey.

UNIVERSAL OIL PRODUCTS COMPANY has increased membership of the board of directors to nine with the election of Fred C. Koch at a special stockholders meeting here. Koch is chairman of the board of Koch Engineering Company, Inc., of Wichita, Kansas., and a director of the First National Bank of Wichita.

NAME CHANGE. C-B Southern, Inc., is the name given to Creole Engineering Corporation as a result of its acquisition by Cooper-Bessemer Corporation, Houston, Texas. T. E. Kraner has been named president of the subsidiary operation.

OIL WELL SUPPLY DIVISION U. S. Steel has recently announced changes in personnel. J. E. Shoemake, new manager —refining and pipeline equipment sales, Houston; Gilbert L. Heidler, area manager, refining and pipeline equipment sales, Houston; D. O. Smith, area manager, tubular sales, Houston; R. F. Cann, retired following 35 years of service; Wallace L. Reed, division district engineer, has been transferred from Houston to Jackson, Mississippi. Harold C. Nicholson is the new manager in Corpus Christi, Texas. Carl C. Egner has retired after 23 years with "Oilwell." B. A. August has been transferred from San Antonio, Texas to New Orleans, Louisiana. H. W. Solsbery has moved from New Orleans to San Antonio.

▸ **E. E. Storey** has joined Jones & Laughlin Supply Division at Tulsa as supervisor — tank sales. The company recently announced an agreement with Continental Tank Company of Oklahoma City for exclusive distribution of Continental leasehold storage and processing equipment. **R. N. Maples** has been appointed manager—traffic department. He replaces **C. J. (Jack) Jernigan,** who has retired.

▸ **Walter A. Penner** is the new district office manager of the Worthington Corporation's Denver district office. He replaces **C. R. Walbridge,** who has resigned.

▸ **C. Horace Sanders** has been named southwest district manager for The Cooper-Bessemer Corporation, Mount Vernon, Ohio. He fills the post formerly held by **A. A. Burrell,** who is retiring after 33 years of active service.

▸ **Newton R. Crum** has been named manager of Lunkenheimer's Los Angeles office. **J. Paul Scherer** is the new sales representative assigned to the New York City office.

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Last year the buses in America carried more than seven billion passengers. These buses travelled more than four billion miles. In today's space talk, that is equal to more than eight thousand trips to the moon and back!

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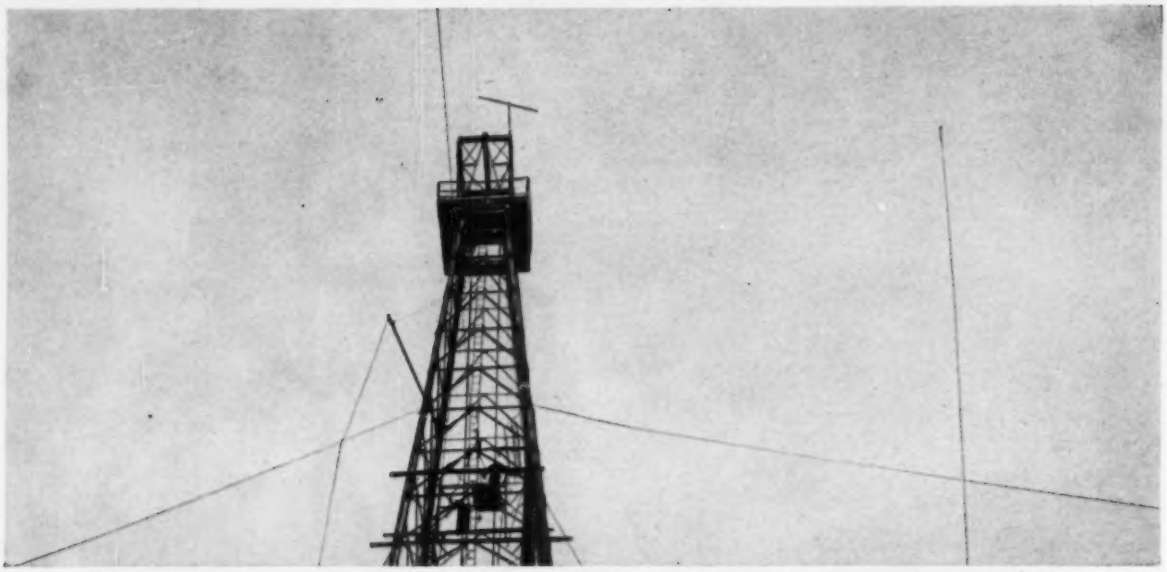


"We depend on G-E narrow band radio for 99% of our communications with our men . . ."

says Watt Taylor, Vice President of Lowe Drilling Co., Midland, Texas

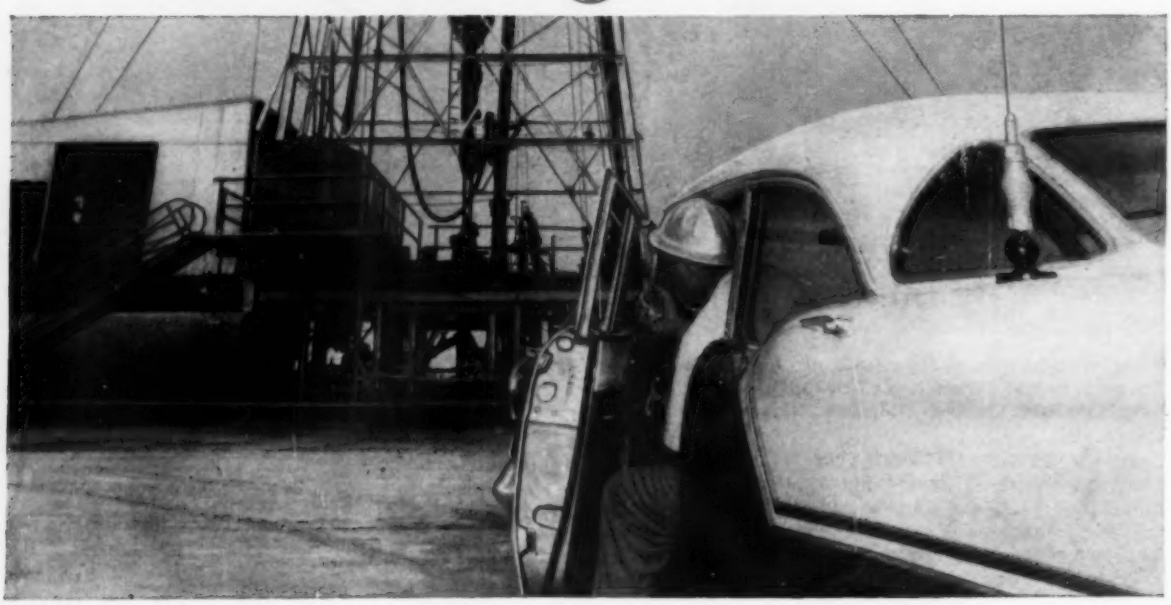
Five years ago Lowe Drilling Co. saw that dependable two-way radio would save countless hours and miles of travel, and make it possible to talk with men working far from any telephone. Lowe started with one General Electric base station and four mobile units, today has three base stations and 22 mobiles. As recommended and pioneered by the Petroleum Industry Radio Association, Lowe chose narrow band (split channel) units for minimum interference.

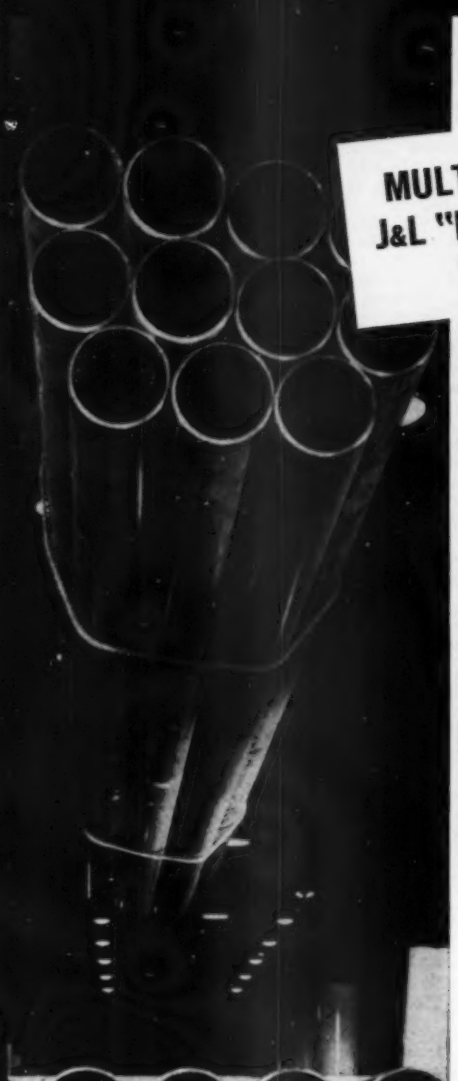
Why convert later? Buy narrow band now

Now that the law requires split channel operation, it will pay you to work with the leader in this field. General Electric has been making and servicing narrow band equipment for nine years—longer than any other manufacturer. Split channel capability is engineered into G-E radio from the start; it's not an afterthought or an adaptation.

An experienced G-E communications consultant will help you develop the most efficient and economical system for your needs. Look under "Radio Communication Equipment" in the Yellow Pages. Or write General Electric Company, Communication Products Dept., Section 31118, Syracuse, N. Y.

GENERAL ELECTRIC





MULTIPLE-TESTED J&L "ELECTRICWELD" LINE PIPE

J&L's 12¾-inch Electricweld line pipe was used in 22 miles of this Cherokee Pipe Line Company line.

"J&L Electricweld pipe bends readily to contours, is easy to weld"

. . . reports Pipe Line Service Company

Twenty-two miles of J&L's 12¾-inch O.D. Electricweld line pipe were installed by the Pipe Line Service Co., Seminole, Okla., in this line for the Cherokee Pipe Line Co.

"Our pipe must be uniformly round, bend readily to correct contour, and weld easily," says this pipeline contractor. "J&L pipe meets our specifications. It enabled us to avoid delays on this job over hilly terrain."

Electricweld line pipe is produced by Jones & Laughlin, an integrated steel company, under most rigid quality controls. Weld area of the steel is blasted with steel grit under 100 psi in a "Vacu-Blast" unit to clean the surface for perfect contact with the welding electrode.

During the electric resistance-welding process, electronic controls maintain exact welding heat at all speeds. After welding and trimming, pipe passes through an induction annealing unit to assure uniform grain structure in the weld area.

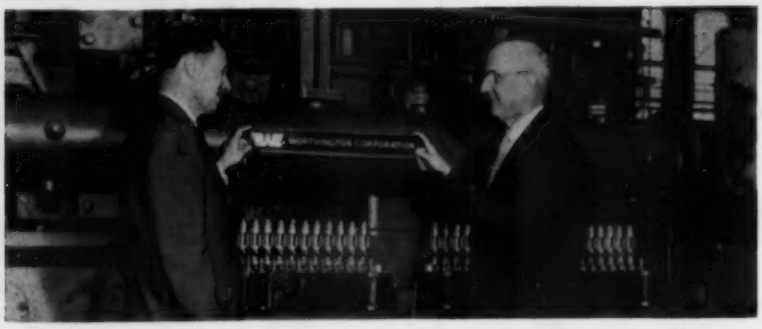
Every length of pipe is thoroughly checked through visual examinations, hydrostatic tests, flattening tests and magnaflux inspections. All Electricweld pipe is manufactured and tested in strict compliance with appropriate A.P.I. and A.S.T.M. specifications.

Electricweld pipe is available from 6⅝ inches through 12¾ inches and in lengths to 60 feet. Get the facts on this superior quality line pipe from your distributor, or write to Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pa.

J&L STEEL

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA



A typical use of the brand-new Worthington Corporation trademark is shown by two company officials at the firm's Buffalo, New York, plant. They are, left, V. M. Holmes, assistant manager of Engine Sales and George Stevens, general manager of the Compressor and Engine Division. The design was recently created as a more modern trademark.

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PIPE NIPPLES — All Sizes and Types

STEEL BUSHINGS AND PLUGS — 3000 Lb.

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X

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Denver, Colo. — W. G. Cline & Co., 4500 Kalamath
Detroit, Mich. — R. W. Lang, Jr., 505 Park Avenue
Erie, Pa. — R. J. Maggi, Box 711
Falmouth, Mass. — Walter S. Bennett, 5 Belvidere Road
Grand Rapids, Mich. — R. W. Lang, Jr., 138 Burton SE
Houston, Tex. — Henry H. Paris Distributor, Inc., Box 932
Independence, Mo. — Craig A. Fross, 3701 Norwood
Long Island City, N.Y. — Max Rothenberg Co., Inc., 11-05 38th Ave.
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Louisville, Ky. — Sid Schultze Co., 849 S. 6th St.
Narberth, Pa. — Worthington-Grothaus and Associates, 105 Forrest Ave.
Omaha, Nebr. — Wm. Freiden, Central States Engineering & Sales Co., 5101 Blonde St.
Oswego, N.Y. — Northeastern Associates, Neil Chatterton, Sec'y, P.O. Box 284
Portland, Ore. — J. G. Beard Co., 1233 NW 12th Ave.
Richmond, Va. — P. C. Abbott & Co., 15 E. Franklin St.
St. Louis, Mo. — Walter C. Dollinger Co., 4869 Goodfellow Ave.
Salt Lake City, Utah — Lovell Company, 29 E. 2nd St. South
Seattle, Wash. — Ashe & Jones, 819 Thomas St.
Wauwatosa, Wis. — W. G. Nelsen, P. O. Box 203

QUALITY-CONTROLLED PIPE COUPLINGS SINCE 1918

▸ **Garrett E. Kauffman** has been appointed assistant controller of The National Supply Company. He succeeds **Gordon R. Graham,** who was recently promoted to controller. Other changes affecting the company's accounting department: **E. B. Malloy,** appointed manager — general accounting; **Theodore Fox,** manager — general auditing; and **W. Edward Wotring,** manager — electronics planning.

REORGANIZATION OF HUGHES TOOL sales personnel is announced. **Park L. Myers** has been made manager of United States and Canadian sales, and **E. M. Connor** manager of export sales. Both are under **W. H. Siems,** general sales manager. Export sales activities have been divided into Western and Eastern Hemisphere territories, with **O. B. Latrobe,** New York, heading Western Hemisphere sales and **R. G. Roberts,** London, Eastern Hemisphere sales.

Leon Stinson moves to Houston as director of sales training. **J. R. Lesch** moves to Houston as manager-rock bit sales. **R. W. Lewis** becomes manager-tool joint sales.

Throughout the United States and Canada new regional and divisional organizations have been added or realigned to furnish improved service. Seven new regional headquarters with respective managers are as follows: Dallas, **T. G. Whiddon;** Houston, **W. W. Hampton;** Denver, **S. J. Lintzenich;** Midland, **M. A. Foreman;** New Orleans, **F. T. Alexander;** Tulsa, **H. M. Kelly;** and Canadian, **R. D. Hood.**

▸ **J. H. Coman** has been appointed vice president of W. C. Norris, manufacturer, a division of Dover Corporation. He will direct the operations of the material warehouse control, and shipping departments, and also be responsible for the recently organized machine tabulating department.

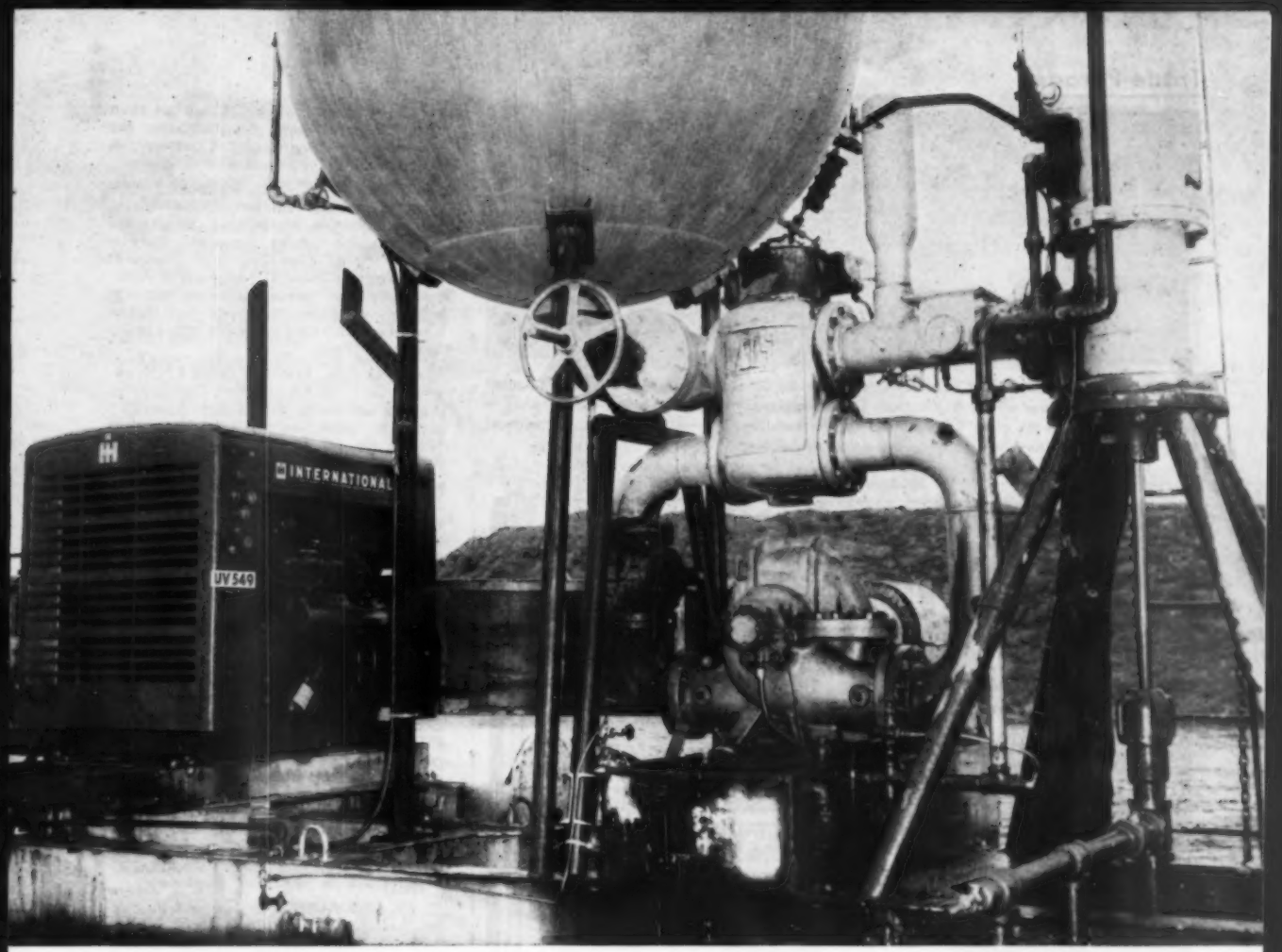
▸ Appointment of **Robert Habermehl Jr.** as technical service director for Girdler Catalysts is announced by the Chemical Products Division of Chemetron Corporation. He will make his headquarters in Louisville and be in charge of the technical service staff.

TUBE-KOTE, INC., of Houston, Texas, dedicated a new research laboratory recently. New laboratory facilities house Tube-Kote's quality control, production control, the research sections, and the coating evaluation activities of the firm.

▸ **J. R. McReynolds** has been transferred to the general headquarters of The Youngstown Sheet and Tube Company as assistant district traffic manager. He had been manager of the traffic and purchasing departments, Continental-Emsco Company, a division of Youngstown, since March 1956.

FORMATION OF A PROCESS CHEMICALS department by the Industrial Chemicals Division of American Cyanamid Company has been announced. The new department, created through the merger of the company's heavy chemicals and manufacturers chemicals departments, will service the wide range of industry's chemical needs with an extensive line of intermediate, heavy and specialty chemicals for the process industries. H. C. Milton has been appointed manager of the department and R. M. Goddard has been named sales manager. Principal office and eastern regional headquarters of the process chemicals department will be in New York City.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Modern Look in Smooth Oil Well Pumping Performance

This heavy duty International V-8 oil field engine owned by L. A. Harnish, operator, of Fresno, Calif., teamed with an Axelson long stroke hydraulic pumping unit, is the modern version of smooth oil field pumping performance.

Operating at low cost on gas from the well being pumped, this 549 cu. in. displacement V-8 cylinder unit is located in the Guajjarral Hills field 10 miles east of Coalinga, Calif. Long periods without service attention are made possible by use of a Ren oil level regulator and make-up tank, automatic safety shutoff controls, generous radiator cooling capacity with automatic thermostatic by-pass engine temperature regulation, and overall heavy-duty construction.

It will pay you to investigate the cost reductions possible with this new look in smooth power on your pumps, compressors, and drill rigs. Get full facts on the three new International V-8 and seven 6-cylinder natural gas engines from your nearby International Power Unit Distributor or Dealer. See how modern engine design combined with the best of accessories can be matched to modern oil field equipment to reduce your production costs. Call today and find how little it costs to switch to International.

International® **Construction Equipment**

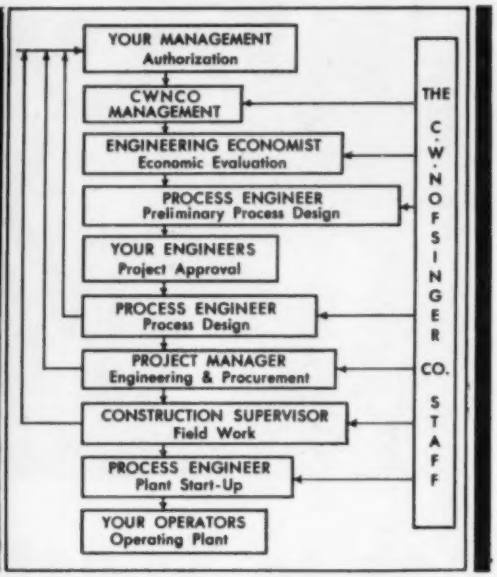
International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carburated Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

Wyatt Metal & Boiler Works, Inc. is now occupying its new three-story and basement addition to its general offices in Houston. The added space permitted other departments to have larger space in the older two-story part of the building. Wyatt's Plastics, Inc., formerly at 5928 Kansas Street, now has offices in the enlarged building.

FLOW DIAGRAM

Your Project— from Inception to Operating Plant



THE C. W. NOFSINGER COMPANY provides complete services — Development, Engineering and Construction — Petroleum and Petrochemicals — on your new process, or licensed processes, or any of the numerous processes and operations within the broad experience of The C. W. Nofsinger Company.

As the diagram emphasizes, the entire C. W. Nofsinger Company organization is brought to bear on your project as needed, and our engineers collaborate closely with your personnel to ensure that your requirements are met in every regard.

We shall be pleased to serve you and welcome your inquiries.

Representatives

WEST COAST—A. R. Chandler, 609 S. Grand Ave., Los Angeles 17, Calif.
GULF COAST—Russell G. Dressler, 204 Carolwood Dr., San Antonio 13, Tex.

"In Engineering, it's the PEOPLE that Count"

THE C. W. NOFSINGER CO.

Engineers and Contractors for the Petroleum and Chemical Industries

307 East 63rd Street **Kansas City 13, Missouri**

▸ **J. B. Allinson,** Dallas, Texas, has been named regional sales representative for Southwestern Engineering Company in the mid-continent and southwest areas.

▸ Blaw-Knox Company, Buflovak Equipment Division, Buffalo, New York, named **Robert B. Scrimgeour** special sales representative for the company's ROTO-VAK Agitated Film Contactor. **James T. Langham** of James T. Langham & Associates, oil and gas consultants, was appointed sales representative for Blaw-Knox Gas Cleaners in Oklahoma, Louisiana, and Texas.

MACCO OIL TOOL COMPANY appoints the L. A. Christopher Company as representatives in the Rocky Mountain area for sales, service and design of Macco gas lift installations. Offices are in Denver and Durango, Colorado.

▸ **J. C. (Jack) Thompson,** station manager for Dowell Division of Dow Chemical Company at Hays, has been transferred to United Oilwell Service S.A., Anaco, Venezuela. He is succeeded by **H. D. (Hal) Monical,** who has been transferred to Hays from Winfield, Kansas. United Oilwell is a subsidiary of Dow Chemical. Headquarters are in Caracas.

Other Kansas changes are: **John White** from Derby to Eureka as service engineer and **James R. Day** from Maracaibo, Venezuela, to Winfield, Kansas, also as service engineer.

▸ **Howard M. Thompson** has been appointed department manager — field application, by the Warren Automatic Tool Company, Houston, Texas. He will coordinate development of new and improved instruments from the research department to their practical application in the oil field. All field testing on the drilling rigs will be under his supervision.

FULL OPERATION of all tube-producing facilities at Calumet & Hecla of Canada, Limited's Wolverine Tube Division plant here has been announced. Calumet & Hecla of Canada is a wholly owned subsidiary of Calumet & Hecla, Inc., Chicago. The Wolverine Tube plant, Canadian industry's newest source of nonferrous seamless tubing, made its first shipment of copper water tube in April.

▸ **William C. Meeks, Jr.,** sales representative for WECO has been transferred from Hobbs, New Mexico to Denver, Colo.

▸ **Continental-Emsco Company.** E. L. Gamble is new assistant division manager, Kansas-Oklahoma-North Texas Division. George W. Ppool was appointed at the same time to the position of district manager for the Kansas district. Ppool, former assistant district manager for the Kansas area, will have headquarters in Great Bend, Kansas. Gamble joined Continental-Emsco in 1951.

▸ **Reed Roller Bit Company.** B. A. Wendt, former assistant sales manager, has been appointed Texas Gulf Coast division manager with headquarters in Houston, succeeding R. V. Ellis who will transfer to the Southeastern Division, Louisiana, as division manager. A. A. Ezzell, former Corpus Christi manager in the Texas Gulf Coast Division, has been promoted to division manager, North Texas Division, Wichita Falls, Texas.

Reed's Kansas and Oklahoma sales divisions will be combined into one division with headquarters in Oklahoma City. W. H. Armstrong, presently Kansas division manager, will move to Oklahoma City as division manager. B. F. Hanly will move to Denver, Colorado, as area representative in Denver.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Desk and Derrick Elects 1959 Officers

Miss Ellen M. Vaughan, The Carter Oil Company, Shreveport, Louisiana, has been elected 1959 president of the Association of Desk and Derrick Clubs of North America during the annual meeting in October in Los Angeles. Miss Vaughan follows Miss Maxine R. Hacke, Warren Petroleum Corporation, Tulsa, Oklahoma.

Other officers elected were: Miss Harriet Gregath, Tidewater Oil Company, Kansas City, Kansas, first vice president; Mrs. Jeanne E. Merrill, Phillips Petroleum Company, Bartlesville, Oklahoma, second vice president; Miss Lucille Barthlow, Leonard Refineries, Inc., Alma, Michigan, secretary; Mrs. Fae Matson, Gulf Oil Corporation, Fort Worth, Texas, treasurer.

Regional directors are: Region 1, Miss Minnie Neal, The Atlantic Refining Company, Philadelphia, Pennsylvania; Region 2, Miss Paula Mace, Craig & Craig, Mt. Vernon, Illinois; Region 3, Miss Opal Oneale, Lafayette, Louisiana; Region 4, Mrs. Penny Eades, Core Laboratories, Inc., Dallas, Texas; Region 5, Miss Reta Amsler, Western Oxygen, Inc., Odessa, Texas; Region 6, Mrs. Mary Hurley, Sinclair Pipe Line Company, Independence, Kansas; Region 7, Miss Margaret Long, Imperial Oil Ltd., Calgary, Alberta, Canada; Region 8, Mrs. Anna L. Donley, General Petroleum Corporation, Taft, California.

Bulletin Contest Winners Announced

Winners in the 1958 Bulletin Contest sponsored by the Association of Desk and Derrick Clubs of North America were announced at an "All Association" meeting at Los Angeles.

Best News Story: (1) Mrs. Marguerite Blaine, member bulletin staff of *Desk and Derrick Diggin's*, Shreveport, Louisiana, for article on "Everyone Enjoyed Hearing John B. O'Conner"; (2) Mrs. Dorothy Monroe, Dallas, Texas, for "Dallas Club Welcomes Petroleum Women to Spring Workshop" in *Diamond Bits*; (3) Miss Elizabeth Bryant, member bulletin staff of *The Catline*, Houston, Texas, for "Oil Industry Participates in the Space Age."

Best Feature Story: (1) Mrs. Anne Bayer, Winnipeg, Manitoba, Canada, for article, "An Innocent Abroad in This Fascinating Oil Business", published in *Derrick Damsels Data*; (2) Mrs. Dorothy Strickland, El Dorado, Arkansas, for "Two-Timing Woman", *The El Dorado*, (3) Mrs. Stelle Condry, Pittsburgh, Pennsylvania. Article on "Magic wOILd" in *Drake's Daughters*.

Best Editorial: (1) Miss Naida H. Martyn, member 1957 bulletin staff of *The Gusher*, San Antonio, Texas for article on "Public Relations"; (2) Mrs. Clara Gibson, 1957 editor, *Drill Bits*, Baltimore, Maryland, for "Progress Through Education"; (3) Mrs. Virginia Dupies, Dallas, Texas, for article "Loyalty", in *Diamond Bits*.

Best Art or Graphic: (1) Miss Betty Sampson, 1957 editor, and Miss Wanda McLin, member bulletin staff of *The Gusher*, San Antonio, Texas; (2) Mrs. Sylvia Ann Galo, 1957 editor *Desk and Derrick Times*, New Orleans; (3) Mrs. Pat Tankersley, staff artist for *Black Magic*, Duncan, Oklahoma.

Best All Round Bulletin: (1) Miss Teresa Kosiba, editor *Drake's Daughters;* (2) Mrs. Nora Cunningham, editor *Black Magic*, Duncan, Oklahoma; (3) Miss Irma Cline, editor *Gas and Gals*, Wichita Falls, Texas.

WISCONSIN-POWERED Machine

Bends Pipe to Fit Terrain

...at Pressures Up to 250 TONS!

HANDLING pipe of any size from 6-in. to 20-in. dia., and up to ½-in. thick in the largest size, this Wisconsin-powered "CINCH WV Series" Vertical Pipe Bending Machine makes practically any desired bend . . . tailor-made to fit the terrain and the contour of the space for laying the pipe.

Even on the greatest angles of the bends, the pipe thickness is kept uniform and free from ripples or wrinkles, according to the manufacturer, M. J. Crose Mfg. Co., Inc., Tulsa, Okla. The actual bending operation is performed by four hydraulic cylinders which exert pressures up to 250 tons at the places where pipe is to be bent. The hydraulic pump which activates the cylinders, is powered by a MODEL VG4D (37 hp.) WISCONSIN HEAVY-DUTY AIR-COOLED ENGINE, equipped with electric starting and generator.

In addition to its value in oil field service, this machine is said to be an ideal piece of equipment for medium or small-sized contractors, as a permanent investment. It is not uncommon to see one of these small bending machines operating on busy thoroughfares in metropolitan areas, where until recently only fittings or welding methods were used.

Wherever there's a tough power job to be done, you'll find Wisconsin Engines (3 to 56 hp.) delivering High Torque, Load-Holding power service . . . operating at temperatures from low sub-zero to 140° F. *You* can't do better than to specify "WISCONSIN" for *your* equipment. Write for Engine Bulletin S-223.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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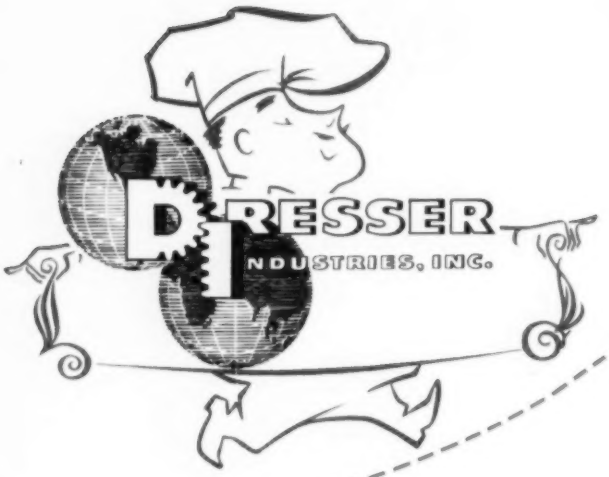
3430 McKINNEY AVENUE • HOUSTON, TEXAS
505 SOUTH MAIN STREET • WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

AB-6207



Dresser Industries and its

Security Engineering and

Turbodrill Divisions invite you to bring a

DRESSER INDUSTRIES *and its companies are pleased to be your hosts again at the API SNACKBAR — where you meet your friends during this important API annual meeting. Dresser Industries and these 14 Dresser companies offer their best wishes for a successful meeting:*

CLARK BROS. CO. — *compressors and gas turbines* • **DRESSER DYNAMICS, INC.** — *advanced scientific research* **DRESSER-IDECO COMPANY** — *steel structures* • **DRESSER MANUFACTURING DIVISION** — *couplings* • **HERMETIC SEAL TRANSFORMER CO.** — *electronic transformer development* • **THE GUIBERSON CORPORATION** — *oil tools* **IDECO, INC.** — *drilling rigs* • **LANE-WELLS COMPANY** — *technical oilfield services* • **MAGNET COVE BARIUM CORPORATION** — *drilling mud* • **PACIFIC PUMPS, INCORPORATED** — *pumps* • **ROOTS-CONNERSVILLE BLOWER DIVISION** — *blowers and meters* • **SECURITY ENGINEERING DIVISION** — *drilling bits* • **SOUTHWESTERN INDUSTRIAL ELECTRONICS** — *electronic instrumentation* • **WELL SURVEYS, INC.** — *nuclear and electronic research*

BUFFET LUNCHEON

EXHIBITION HALL

CONRAD HILTON HOTEL

CHICAGO

TUESDAY, 11:30-2:00 P.M.

NOVEMBER 11, 1958

friend and enjoy their...

Meetings

Nov. 17-19—**NACE**, western region meeting, Los Angeles, Calif.

Nov. 19-21—**Society of Petroleum Engineers**, Local Sections, Venezuela.

Nov. 21—**NGAA**, Panhandle Plains regional, Herring Hotel, Amarillo, Texas.

Nov. 28-Dec. 4—**Electronic Computer Symposium and Exhibition**, Olympia, London, England.

Nov. 30-Dec. 5—**ASME**, annual meet, Statler & Sheraton-McAlpin hotels, New York City, N.Y.

Dec. 2-4—**The Asphalt Institute**, annual membership meeting, Shoreham Hotel, Washington, D. C.

Dec. 3-5—**API** Oil Information Committee meeting, Waldorf-Astoria Hotel, New York City, N.Y.

Dec. 7-10—**American Institute of Chemical Engineers**, annual meeting, Netherland Plaza Hotel, Cincinnati, O.

1959

Jan. 19-22—**American Road Builders Assn.**, 57th annual convention, Dallas, Texas.

Jan. 23—**NGAA**, Oklahoma regional meeting, Biltmore Hotel, Oklahoma City, Okla.

Jan. 26-29—**Plant Maintenance & Engineering Show**, Public Auditorium, Cleveland, Ohio.

Feb. 9-11—**AAPG**, Rocky Mountain Section, 9th annual meeting, Civic Auditorium, Albuquerque, N. M.

Feb. 15-19—**AIME**, annual meeting, Sir Francis Drake Hotel, San Francisco, Calif.

Feb. 16-19—**AAPG-SEPM**, 44th annual meeting, Memorial Auditorium, Dallas, Tex.

Mar. 1-5—**ASME**, gas turbine power conference & exhibit, Netherlands-Hilton Hotel, Cincinnati, O.

Mar. 4-6—**API**, southwestern district meeting, Scharbauer Hotel, Midland, Tex.

Mar. 16-20—**AIChe**, Chalfonte Haddon Hall, Atlantic City, N. J.

Mar. 16-20—**NACE**, 15th annual conference and exhibition, Sherman Hotel, Chicago, Ill.

Mar. 17-19—**NACE**, 1959 Corrosion Show, Sherman Hotel, Chicago, Ill.

Mar. 25-27—**API** Division of Production, southern district meeting, Roosevelt Hotel, New Orleans, La.

Mar. 31-Apr. 1-2—**Illinois Institute of Technology**, 21st American power conference, Hotel Sherman, Chicago, Ill.

Apr. 2-3—**Society of Petroleum Engineers of AIME**, Rocky Mountain petroleum section, 5th annual joint meeting, Casper, Wyo.

Apr. 5-9—**The 1959 Nuclear Congress**, Cleveland Auditorium, Cleveland, O.

Apr. 6-7—**Instrument Society of America**, 2nd National Symposium on Chemical & Petroleum Instrumentation, St. Louis, Mo.

Apr. 8-10—**API** Division of Production, eastern district meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 15-17—**National Petroleum Assn.**, semi-annual meeting, Hotel Cleveland, Cleveland, O.

Apr. 19-23—**ASME**, oil and gas power conference & exhibit, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 22-24—**API** Division of Production, mid-continent district meeting, Herring Hotel, Amarillo, Tex.

Apr. 30-May 1—**API** Division of Production, Pacific Coast district meeting, Biltmore Hotel, Los Angeles, Calif.

May 4-8—**API** Safety & Fire Protection Committees, 12th midyear meeting, Rice Hotel, Houston, Texas.

Most modern chart plant in America!

ARCCO steps up production at . . .

New Factory

32 years of growth

A new factory is like a new tool and in the case of Arcco we have "tooled" up for a new era in high speed production of highly accurate charts to meet ever growing needs of our vast clientele, both domestic and foreign. Our friends and customers are especially pleased to know that with new equipment, new processes and completely air-conditioned storage for 25,000,000 charts, we shall within a short period of time improve upon our delivery schedule. These new facilities, we hope, will help us maintain the present price schedule despite rising costs.

We wish to express our appreciation to several thousand regular purchasers of our charts, instruments, etc., for their patience and tolerance with us during the past crucial years when deliveries have certainly been a problem.

We cordially invite our friends to visit the new plant any time they are in the vicinity.

AMERICAN

RECORDING CHART COMPANY

7142 East Condor Street, Los Angeles 22, California

Statement Required by the Act of August 24, 1912, as Amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) Showing the Ownership, Management, and Circulation of

THE PETROLEUM ENGINEER

Published monthly, semi-monthly in July, at Dallas, Texas, for October 1, 1958.

1. The names and addresses of the publisher, editor, and business managers are:

Publisher: The Petroleum Engineer Publishing Company, 800 Davis Bldg., Dallas, Texas.

Editor: J. E. Kastrop, 800 Davis Bldg., Dallas, Texas.

Business Manager: Joe B. Woods, 800 Davis Bldg., Dallas, Texas.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

American Security Life Insurance Company, Marshall, Texas.

Fidelity National Life Insurance Company, 403 South Akard, Dallas, Texas.

Investors Life Insurance Company, 403 South Akard, Dallas, Texas.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

Reserve Life Insurance Company, 403 South Akard, Dallas, Texas.

4. Paragraph 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

J. E. Kastrop, Editor.

Sworn to and subscribed before me this 1st day of October, 1958.

(Seal) Lillian H. Johnston
Notary Public, Dallas County.
(My commission expires June 1, 1959.)

no more knuckle-busting . . .

New RIDGID No. 450 Portable Tristand Chain Vise

has Large Easy-to-Operate Top Screw Handle right up on top

Capacity, ⅛" to 5"
Weight, 42½ Lbs.

Here's a real time saver. Not only do you get a complete work-bench that's truly portable, but now you get a chain vise that's extra easy and fast to operate. Handle is right up on top where it's always handy. Handle and tightening nut are anchored to vise base . . . can't pull out.

Vise base, that overhangs front legs for clear tool swing, has hanger slots for tools, 3-size pipe bender, rear pipe rest and adjustable ceiling brace screw. Folding legs and integral tray set up easily and lock in position for rigid work base. Snap chain holds folded legs closed for easy carrying . . . no loose parts. Rubber grommets in tristand feet prevent creeping. See and try this more-for-your-money RIDGID Top Screw Chain Vise at your Supply House!

New RIDGID Bench Chain Vises have same Extra-Efficient Top-Screw Adjustment...

5 Sizes, for ⅛" to 8" Pipe, Conduit or Rod

The Ridge Tool Company • Elyria, Ohio • U. S. A.

KOEHRING® 3/4-YARD 305 HOE

TRACTOR-TYPE CRAWLERS are available on Koehring 305 for operating over rough cross-country terrain — *plus* independent 2-speed traction (optional).

25-TON CAPACITY ON RUBBER . . . Mobile, truck-mounted 305 (above) has crane-clamshell-dragline-shovel-hoe versatility. It's also available as a 25-ton Cruiser® crane, with one-man operation, and 18 mph mobility. Other Koehring sizes: cranes from 10 to 95-ton capacities. Shovels from ½ to 3 yards.

K841

It's heavy-duty . . . with a big "plus" in extra work capacity

There are several good reasons why you should look into this Koehring heavy-duty ¾-yard hoe. For one thing, you get exceptionally wide work range on cross-country trenching, or slush pits, footings and other below-grade excavations. As a pipeline machine on tractor-type crawlers (optional) it digs 19 feet-9½ in. below grade. Long reach puts spoil bank well back beyond edge of cut — or gives up to 12 foot-10 in. clearance height (at beginning of dump) to load trucks. ¾-yard dipper cuts 40 inches wide over sidecutters.

Antifriction power-flow on dig, hoist, swing and travel assures smooth, dependable operation under maximum loads. Main-drum power clutches require only *1/10th* the lever-pull of comparable-size manual clutches — yet retain accurate "feel" of load. Maintenance on the heavy-duty 305 is simplified, too, because there are only 2 main shafts in the upper machinery. Each assembly is an independent unit with fully-enclosed gears, and splined shafts rotating on antifriction bearings.

You get more work done with every 305 attachment: ¾-yard hoe, shovel, ¾ to 1-yard clamshell, dragline, 15-ton crane. Call Koehring distributor.

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MILWAUKEE **WISCONSIN**

Koehring excavators, cranes also manufactured in:
CANADA • ENGLAND • SPAIN • JAPAN

CONTINENTAL-EMSCO COMPANY has announced the establishment of an industrial sales department which will have the responsibility for direct and dealer sales of Continental-Emsco's Swivel Joints and other industrial products. It will be headed by R. E. "Dick" Scheibel, a former division merchandise manager for the company, who will headquarter in Dallas, Texas. The new department will be a part of the machinery and miscellaneous sales division of Continental-Emsco and will be under the supervision of W. C. Kinder, vice president.

Other changes are: L. Z. Bolding, named store manager at Oklahoma City. Floyd R. Johnson, promoted to store manager at Russell, Kansas. James W. Armstrong has been transferred to Liberal, Kansas, as store manager. David F. Barton, named district D+B specialist, Oklahoma City. James S. Robertson, named D+B specialist at Winnsboro, Texas.

THE PURCHASE of a substantial block of stock in HOMCO by Frederick W. Richmond, New York industrialist, has been announced. George O'Leary, a founder of the 30-year-old oilfield supply and service company, will retain the post of president. Richmond was named chairman of the board. L. Joseph Lawrence, who has been with HOMCO for 23 years, has been named executive vice president and chairman of a newly created management committee. Huntingdon T. Hamm was named secretary-treasurer. He will retain the post of comptroller of the company.

Additions to the board include: Eliot Janeway, New York; Horace Ford, Boston; Clarke Simonds, Providence, Rhode Island; and J. Thomas Kenneally, New York, an associate of Richmond.

Also announced is an advisory committee formed consisting of Robert Ewen, J. E. Peters and E. H. Robertson who will act as senior consultants of the company. In addition to O'Leary, Lawrence and Hamm and the above-mentioned members of the board, other members are: A. W. Waddill and George E. Justice, vice presidents; Thomas C. Smith, Roger M. Freeman, Douglas B. Allison and Weldon Medders.

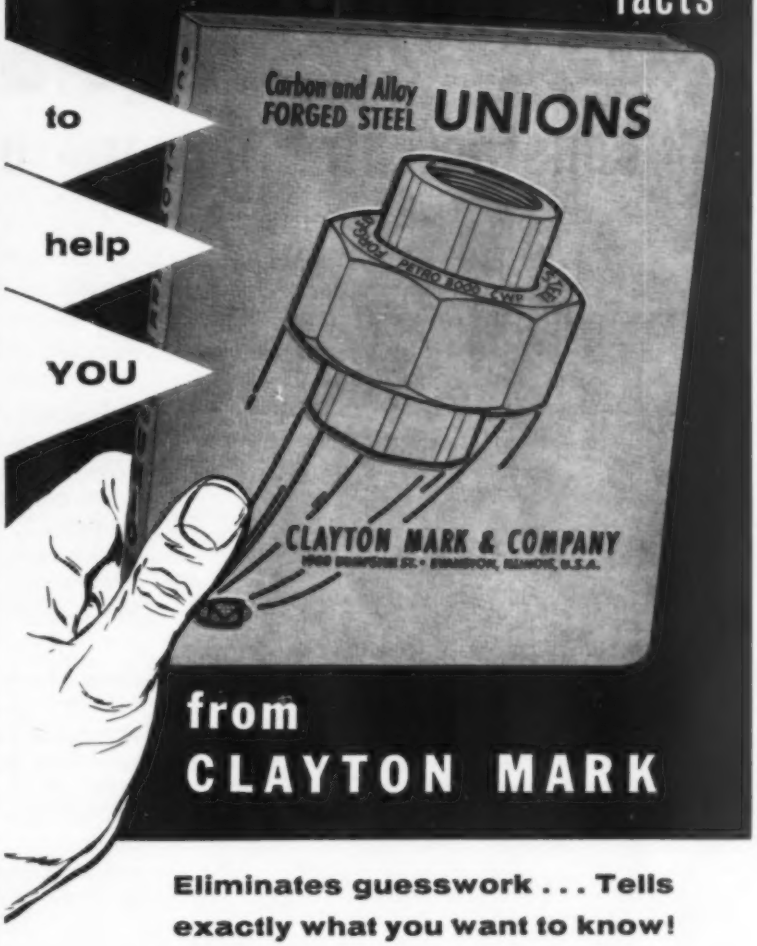
Other changes are: Garland D. Bird from Odessa, Texas, to Farmington, New Mexico; Bernard Killman from Houston, Texas, to Harvey, Louisiana; H. D. Le Blanc from Lake Charles, Louisiana to Houma, Louisiana; Tom J. Lee, Houston, from district manager to sales and service representative; H. B. Meredith from Morgan City to Houma; L. R. Overstreet from Farmington to Sullivan City, Texas; M. B. Watson from Carrizo Springs, to Pearsall, Texas.

ANGLO-AMERICAN COLLABORATION in the service of world industry received a significant boost this week with the signing of a new manufacturing agreement between Armstrong Siddeley Motors Ltd. and Clark Bros. Co., division of Dresser A.G. Terms of agreement provide for licensed manufacture in the United Kingdom of gas turbines designed and made by Clark in the USA.

A NEW DISTRICT for F. H. Maloney Company has been established in the Chicago area which embraces the area within a 500 mile radius. Bob Churnside, sales engineer, will head the office. Joseph V. Kidd has joined the company as a sales engineer in the Houston area.

W. A. "Bill" Davidson has been appointed assistant sales manager at Herb J. Hawthorne, Inc., Houston, Texas.

more new FORGED STEEL UNION facts to help YOU from CLAYTON MARK



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Ready NOW . . . our *new* catalog of Forged Steel Unions that gives all the vital facts you want to know when you order unions. It shows every detail of construction . . . gives you every specification from metal to hardness of seats to exact dimensions.

So complete is the information in this new union catalog that an engineer can draw them into plans and write complete specifications for ANY job requiring pressures to 6,000 lbs. No wading through words. Just plain facts . . . but ALL the facts you need.

Clayton Mark Unions have set standards throughout industry for almost a half century. They are made by the originators of steel unions and the leader in *forged* steel unions—Clayton Mark. They are designed, produced completely, and guaranteed by Clayton Mark. They are your assurance of long life and lower-cost union service.

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- MARK®
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Since 1888 — quality products for industry, farm and home

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NEW American®
GASCLOK Power Drive
constant high power • uniquely accurate

Actual Size

American's new ***GASCLOK*** is a completely self-contained air or gas powered instrument drive and timing unit. Supplying a constant power output of over 20 times the torque delivered by conventional spring-wound clock mechanisms, it is ideally suited as either original or replacement equipment where continuous power and accurate timing are essential.

Perfect for all circular or strip chart records from one-hour to 30-day periods. Constant power and timing accuracy are assured since there is no "mainspring" to weaken or run down. Rugged durability and dependability are built into the ***GASCLOK*** Power Drive for years of service with minimum maintenance. It can provide new metering accuracies and economies for you.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

for instrument driving and timing self-starting • air or gas operated

The versatile ***GASCLOK*** Power Drive is designed and field-tested for long trouble-free operation in remote location installations with all makes and types of recording instruments.

The high-torque, continuous drive provides power for: *Integrating Orifice Meters—Gas Lift Meters—Pressure Recorders Strip Chart Recorders—Telecounter Units—Field Program Timers* and many other instrument applications for accurate, automatic operation.

- **Self-starting mechanism completely self-contained—requires no winding or "priming" of power unit.**
- **Gas or air consumption only 5 cfh—normal operating pressure 5 psi—rotation 2 rpm.**
- **Timing escapement spring rewound every 5 seconds—eliminates fluctuating torque.**
- **Accuracy of timing unaffected by wide fluctuations in supply pressure.**
- **Timing mechanism internally sealed to prevent corrosion and clogging—all power unit parts exposed to gas are aluminum or stainless steel.**
- **Inherently explosion-proof.**
- **Large area internal ports to prevent plugging. All internal ports easily cleaned.**
- **Installation in any position—variety of mounting brackets available.**

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METER COMPANY
INCORPORATED (ESTABLISHED 1836)

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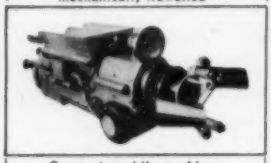

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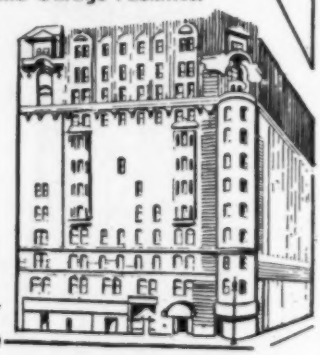

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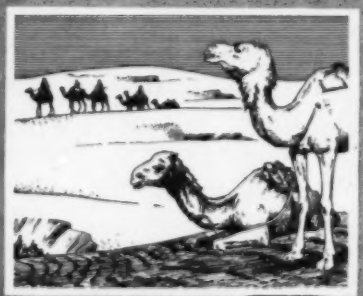

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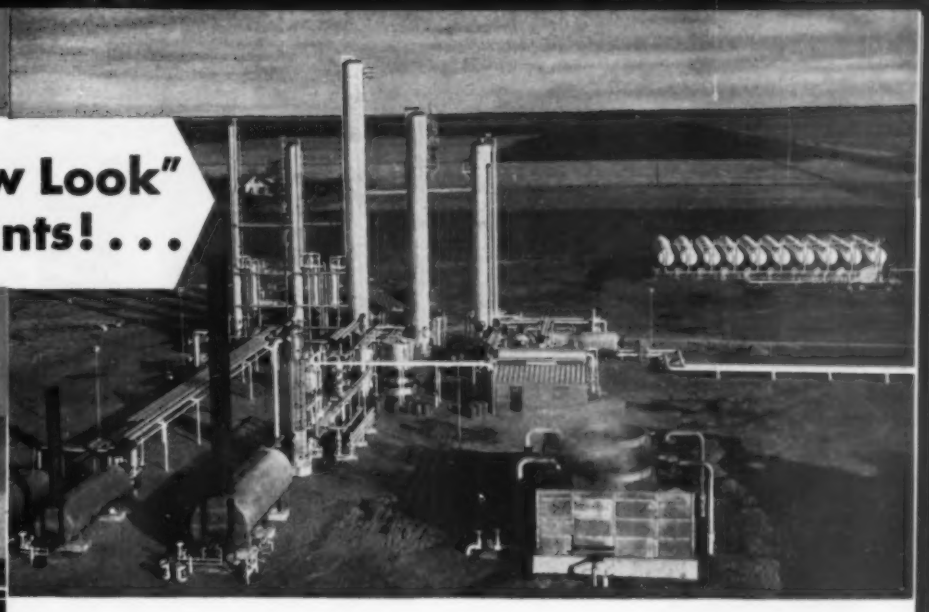

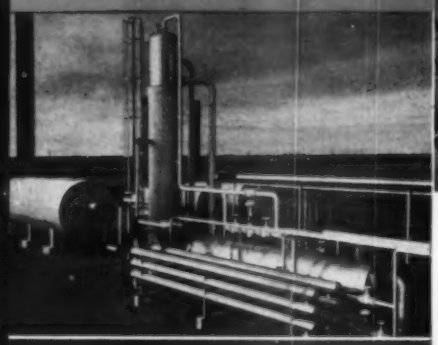

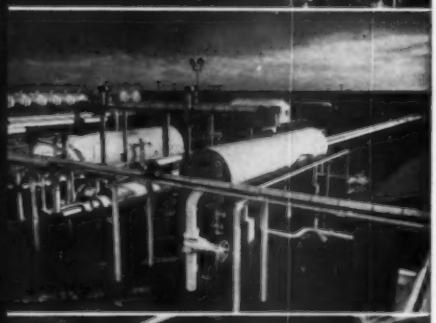

It's KNG'S Big Springs, Nebraska, Plant Using A BS&B Ammonia Absorption Refrigeration Unit And Lean Oil Absorption In Combination!

This plant—designed, manufactured and constructed by BS&B for Kansas-Nebraska Natural Gas Company, Inc.—uses 400 tons of refrigeration supplied by a BS&B Ammonia Absorption Refrigeration Unit to cool both the lean absorption oil and the inlet gas.

Gas enters at 800 psig and 110° F. with a water dew point of (—20° F.), and is passed through water to gas heat exchangers and gas to gas heat exchangers to bring the temperature down to approximately 30° F. It is then further cooled by the ammonia absorption refrigeration unit to 0° F., and enters the bottom of the oil absorber to drop out liquid condensed during the cooling period.

In the oil absorber, the gas at 0° F. is contacted with 140 molecular weight lean oil (also at 0° F.) at a circulation rate of approximately 2.3 gal./1000 SCF. The gas is then warmed to approximately 85° F. before going to the sales line, while the lean oil and absorbed hydrocarbons are passed through conventional fractionation equipment to produce propane, butane and natural gasoline.

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BUTANE—7,987 gal./day
GASOLINE 14#—6,009 gal./day

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INLET GAS COMPOSITION (35 MMSCFD)	MOL. %
N_2	3.24
CO_2	1.37
C_1	80.86
C_2	8.73
C_3	4.43
iC_4	0.34
NC_4	0.57
iC_5	0.17
NC_5	0.17
C_6+	0.12
	100.00

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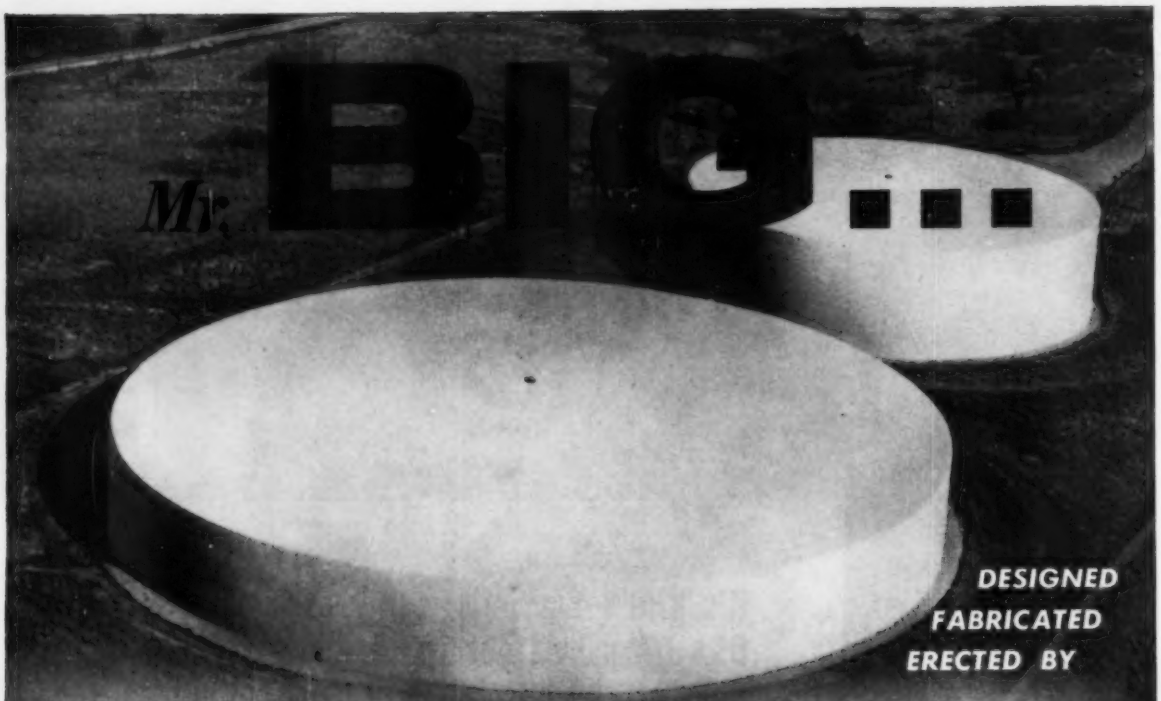

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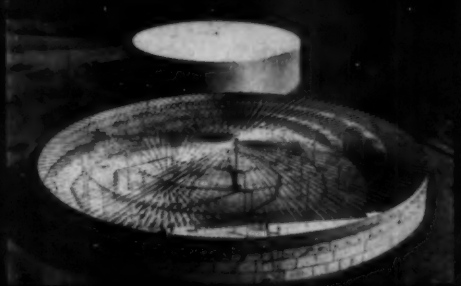

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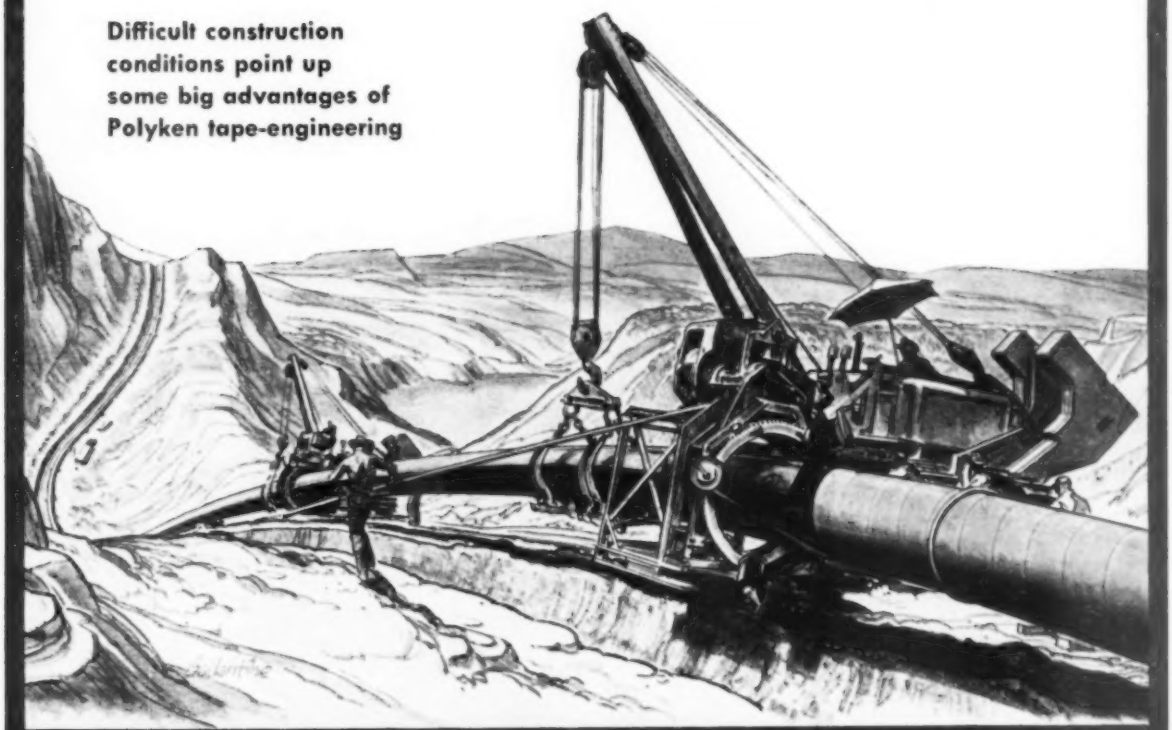
Why do Canadian spreads coat with Polyken tape?

(the proven polyethylene tape)

Difficult construction conditions point up some big advantages of Polyken tape-engineering



Canadian pipeliners have learned their business the hard way. That's why many have turned to Polyken tape and Polyken know-how—for proven results like these:

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6. Liabilities virtually eliminated—no fumes, no burns, no need to worry about human and livestock hazards.

7. Wrap goes into ground in factory-uniform condition.

Today, considering the construction economies regularly reported, you just can't afford to overlook the Polyken method.

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THE KENDALL COMPANY
Polyken Sales Division

If you would like to know more about proven *Polyken protection, contact Polyken Sales Division, Dept. PE11, 309 W. Jackson Blvd., Chicago 6, Ill.*

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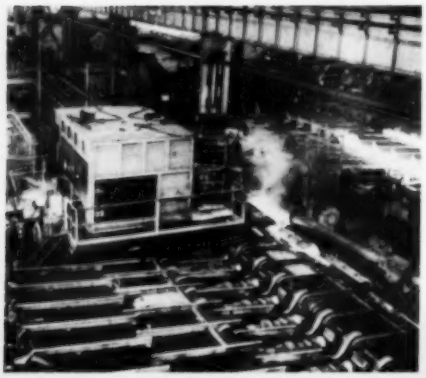
WHEREVER YOU FIND PIPE WITH ORANGE BANDS YOU'LL FIND A SMART PIPE BUYER



Youngstown's ultra-modern, fully-automated No. 3 Seamless Mill —now operating at our Indiana Harbor Works near Chicago— turns out the pipe with the orange bands, the finest made anywhere. Illustrated is the piercing operation at which point a hole is made down the middle of a solid round steel billet. Here is where Youngstown's quality and dependability is built into the pipe with the orange bands.

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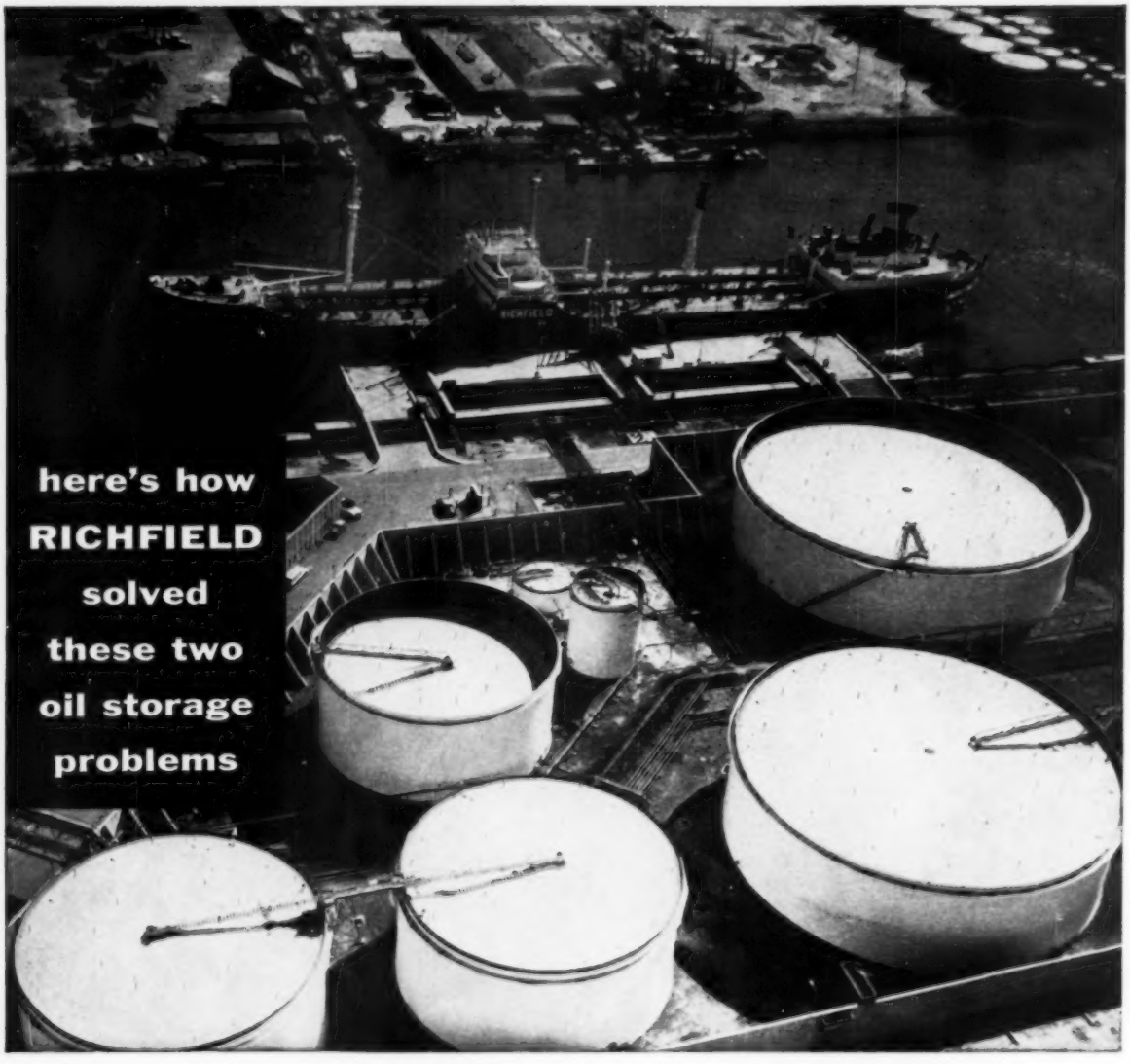

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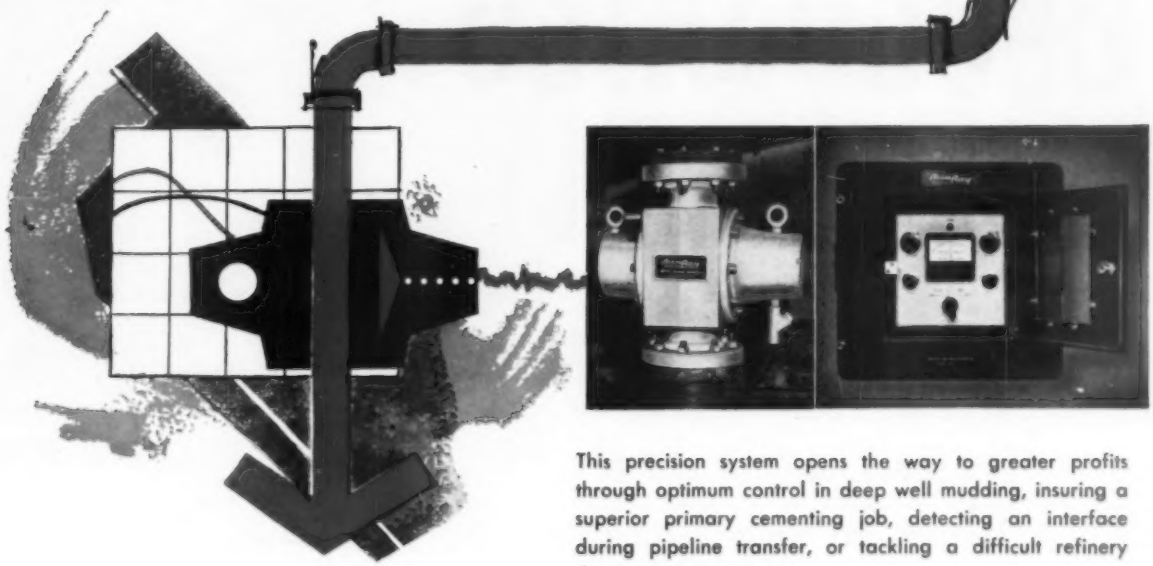
AccuRay now offers the process industries unlimited opportunities for greater profits through increased production and improved quality control. AccuRay's density measuring system gives management greater control over production processes without time-consuming delays for sampling and adjusting the process. Continuous, accurate measurement of density, specific gravity, concentration, or percent solids is essential in determining where economies can be effected. AccuRay's density system provides this information continuously and accurately from the exterior of the pipe, without contacting the process material. The AccuRay Density Measuring System has been designed to meet the rigorous requirements of the process industries. An AccuRay System can play an important part in your modernization plans.



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Keep at it. You never can tell.

* * *

A really good salesman is one who can make his wife sympathize with the girl who lost her compact in his car.

* * *

Success is relative — the more success, the more relatives.

* * *

Wife to sick husband: "What do you mean you have nothing to live for? The house isn't paid for, the car isn't paid for, the TV isn't paid for . . . ."

"Daughter," sighed the hillbilly, "I guess it's just my pride, but I shore wished you could outrun somebody besides Grandpa."

* * *

She: "What causes so many divorces?"
He: "Oh, it's the same old tale."

* * *

"I heard you advertised for a wife. Any replies?"
"Yes; hundreds."
"Good! What did they say?"
"Oh," they all said, "You can have mine."

It's better to give than to lend . . . but it costs about the same.

* * *

Salesman: A fellow with a smile on his face, a shine on his shoes, and a lousy territory.

* * *

Consider the case of Mrs. Day, whose daughter, Theresa, thought to play an April Fool joke.

Bursting into the parlor where, on the afternoon of April 1, Mrs. Day was entertaining her bridge club, Theresa exclaimed excitedly: Oh, mama! There's a strange man in our kitchen and he has our maid on her knees an' he's pettin' her an' kissin' her!"

Excusing herself, Mrs. Day started for the kitchen to put an end to such carryings-on in her chaste household.

"April Fool, mama! It's no strange man at all. It's only daddy."

* * *

Life isn't very fair to us men. When we are born, our mothers get the compliments and the flowers. When we get married, our brides get the presents and the publicity. When we die, our widows get the insurance and the winters in Florida.

* * *

"Porter get me another glass of ice water."

"Sorry, suh, but if I takes any more ice, dat corpse in de baggage car ain't goin' to keep."

* * *

"Isn't this antique furniture gorgeous? I wonder where Mrs. Batts got that huge old chest?"

"Well . . . they tell me her old lady was the same way."

* * *

ALL THAT I AM . . . OR EVER WILL BE . . . I OWE . . .

* * *

Fashion Note: They're wearing the same thing in bras this season.

* * *

One day the five-year-old boy began to wonder why his aunt, who had been married more than 20 years, didn't have any children. He asked her the reason, and she replied:

"Well, darling, I've been looking for a baby in the cabbage patch for years, but I haven't found one yet."

The boy raised his eyebrows. "Well," he said, "if that's how you go about it, no wonder you haven't had any luck."

* * *

The most satisfying experience in life, next to being shot at and missed, is getting an income tax refund.

* * *

It's one thing to itch for something . . . and another to scratch for it.

* * *

You can't blame Nudists for being the way they are — they were born that way.

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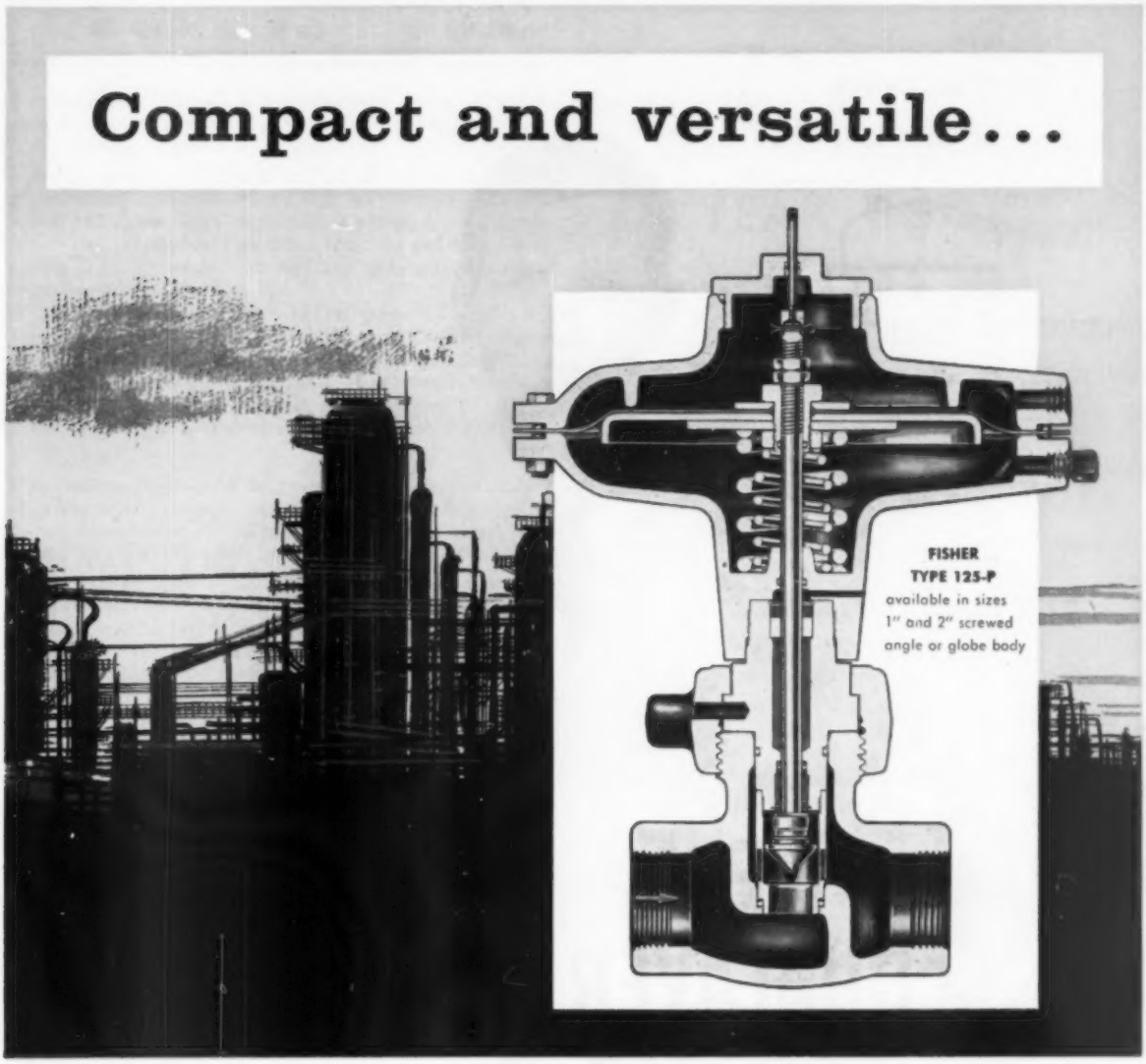

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SHELL DEVELOPMENT COMPANY

Books to Read

Petroleum—Prehistoric to Petrochemicals, *by G. A. Purdy. Published by McGraw-Hill Book Company, 327 W. 41st Street, New York City 36, New York. Pages, 500. Price, $15.*

A full, profusely illustrated account of the petroleum and petrochemical industries—tracing their development from geological and archaeological beginnings to present-day products—is provided in this newly published book. Its author is a consulting engineer, research chemist and technical information specialist with Imperial Oil, Ltd.

Combining basic ideas with the latest technical concepts, this volume is intended to meet the need for an authoritative, standard reference on the technology and products of petroleum. The book describes and shows the nature of petroleum; how it is found, produced, and transported; processes used to convert it into products; and the products themselves and their uses.

Accounting Practices in the Petroleum Industry, *by Robert H. Irving, Jr., CPA and Verden R. Draper, CPA. Published by Ronald Press Company, 15 East 26th Street, New York 10, New York. Pages, 247. Price, $6.*

This book surveys the generally accepted alternative methods of accounting for the frequently encountered transactions that are peculiar to the petroleum industry. These methods are fully explained in their many special applications in the hope that eventually the wide variations in practice may be reduced.

All the basic operations of the industry, from leasing prospective producing properties to refining processes, transportation, and marketing the end products, are described, although emphasis is placed upon accounting for the crude oil production phase.

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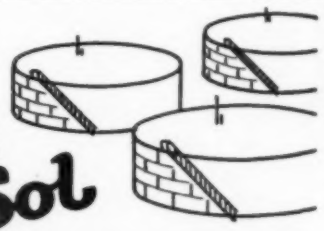

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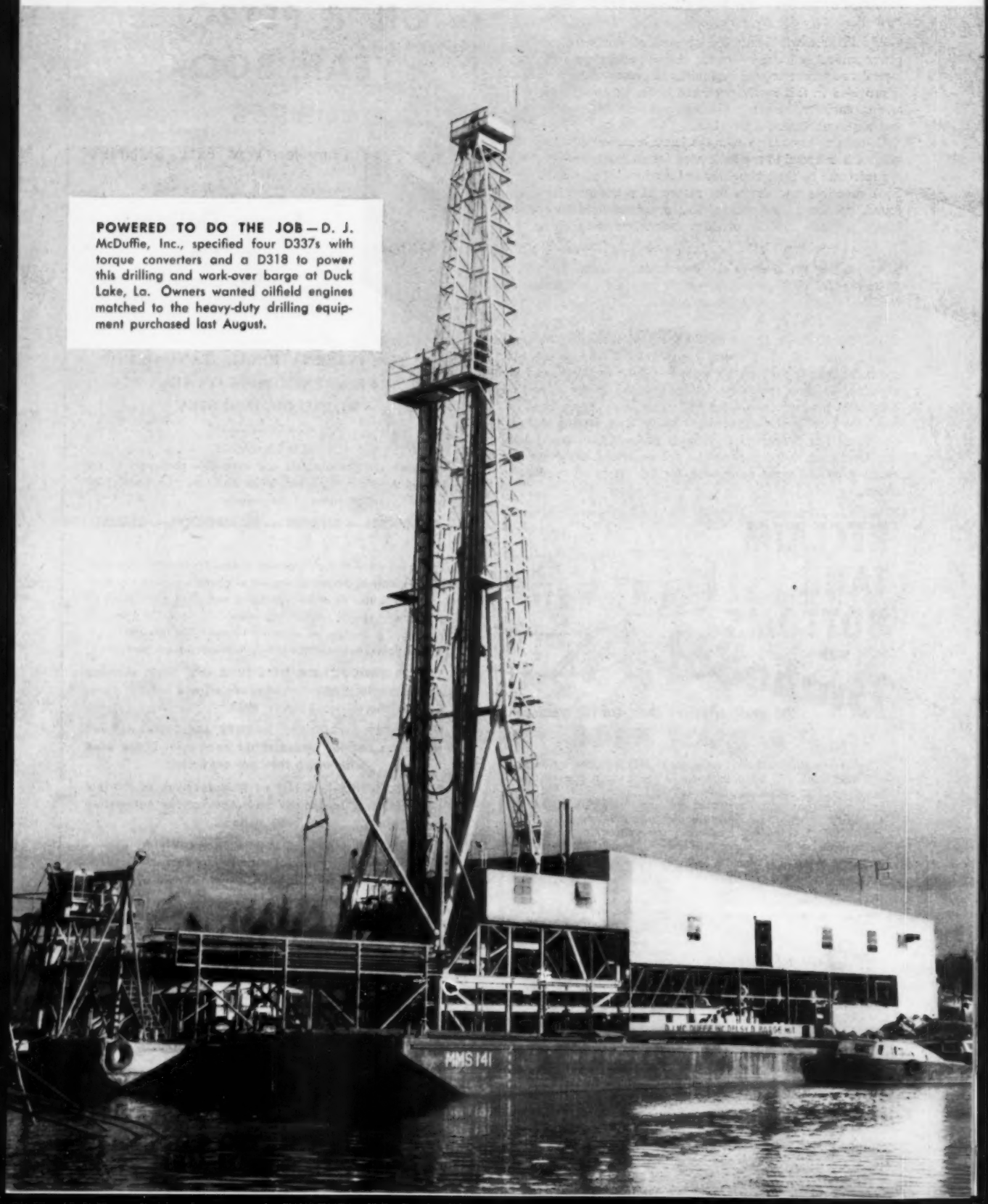
A drilling and work-over rig gets the



POWERED TO DO THE JOB—D. J. McDuffie, Inc., specified four D337s with torque converters and a D318 to power this drilling and work-over barge at Duck Lake, La. Owners wanted oilfield engines matched to the heavy-duty drilling equipment purchased last August.

"power to do the job"–5 CAT Diesels

When D. J. McDuffie, Inc., Plaquemine, La., equipped a new drilling and work-over barge, it wanted engines with the "power and speed to do the job." That's why modern, heavy-duty Cat Oilfield Engines were specified.

As the barge reworks Duck Lake wells in Louisiana, four D337s with torque converters and Ideco compounds drive Ideco drawworks and Gardner-Denver mud pumps. In addition, a D318 drives an Oilwell high-pressure pump. The four D337s are equipped with a keel cooling system.

Here's a barge ready to tackle any job, any time, anywhere. McDuffie, Inc., now has oilfield power that is engineered to match their drill rig equipment. These engines carry a reputation for dependability and low operating cost.

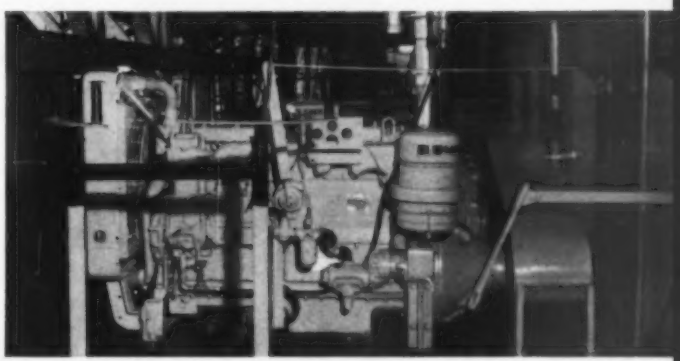
Modern, heavy-duty engines featuring a four-cycle design give you smooth, efficient power. The Cat torque converter automatically adjusts to changing load conditions.

You can choose your power equipment from a full line of Cat Oilfield Engines, available with up to 650 HP (maximum output capacity). These units are also available as diesel and spark-ignition electric sets from 30 to 350 KW (continuous).

So, when you're selecting oilfield equipment, be sure you get the most modern power available by specifying Caterpillar Oilfield Engines. And for replacement power, see your Caterpillar Dealer. He knows the problems of the oilfield.

Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A. Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

FOUR CAT D337 ENGINES with torque converters drive Ideco drawworks and Gardner-Denver mud pumps through an Ideco compound. McDuffie, Inc., switched to Cat Oilfield Engines last August when the new rig was purchased.



THIS D318 DIESEL drives an Oilwell high-pressure mud pump for McDuffie's operations at Duck Lake, La. Like all engines on the rig, it is expected to operate 24 hours a day, the year around.

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Send me more information about Caterpillar Diesel or Spark-Ignition Engines.

☐ I would like detailed information, as I may be in the market for a Cat Engine or Electric Set. I understand that I am under no obligation.

☐ I am interested in learning more about these engines.

Name_____

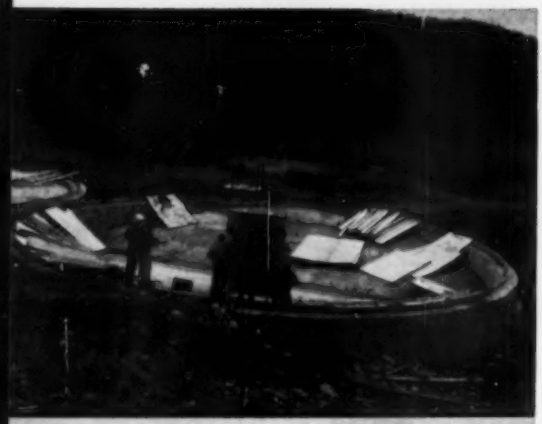
Company_____

Address_____

City_____ Zone____ State_____

NATIONAL® BOLTED STEEL STORAGE TANKS

SOLVE ANOTHER STORAGE PROBLEM IN CENTRAL QUEBEC, CANADA



THE PROBLEM:

Provide storage for 72,000 barrels of cement for a construction job in central Quebec, 200 miles north of nearest rail point. Storage tanks previously used on similar projects were made of wood, which were so difficult to erect and dismantle that they were abandoned when the job was completed, with a total loss of tanks.

THE SOLUTION:

Three 54'-11¾" diameter x 40'-3½" high Bolted Steel Storage Tanks specially designed by National's Engineering Department.

1. The component parts of these tanks were small enough that they were easily shipped to this remote area.
2. The largest shell and deck elements were easily handled by two men.
3. Erection was completed in a very few days.
4. National's anchor base ring provides a positive moisture seal between the concrete foundation and the steel tank shell against high water or drifting snow.
5. The bolted joints are water tight and air tight.
6. The tanks are designed to be quickly and easily dismantled, shipped to a new construction site and re-erected.

   At the same site, this customer is using several smaller National Bolted Steel Storage Tanks to store fuel oil and gasoline.

National Bolted Steel Tanks are used for storage of oil, water, grain, feed, sand, drilling mud, gravel and many other bulk materials.

Let National's Experience Help You Solve Your Storage Problems

It's a National®

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Tried a CABOT Lately?

Pumping units are not to be tried out as a lark. However, sometimes it is well to try a product proven in use by others. If Cabot pumping units have not been among the brand or brands you have recently purchased . . . TRY ONE. It may prove to be more economical than what you are now using. Cabot is a quality pumping unit minus the frills. It is built for most economical overall cost (original outlay less maintenance over the life of the unit) and dependable rugged pumping, 3,000 to 32,000 pounds maximum capacity.

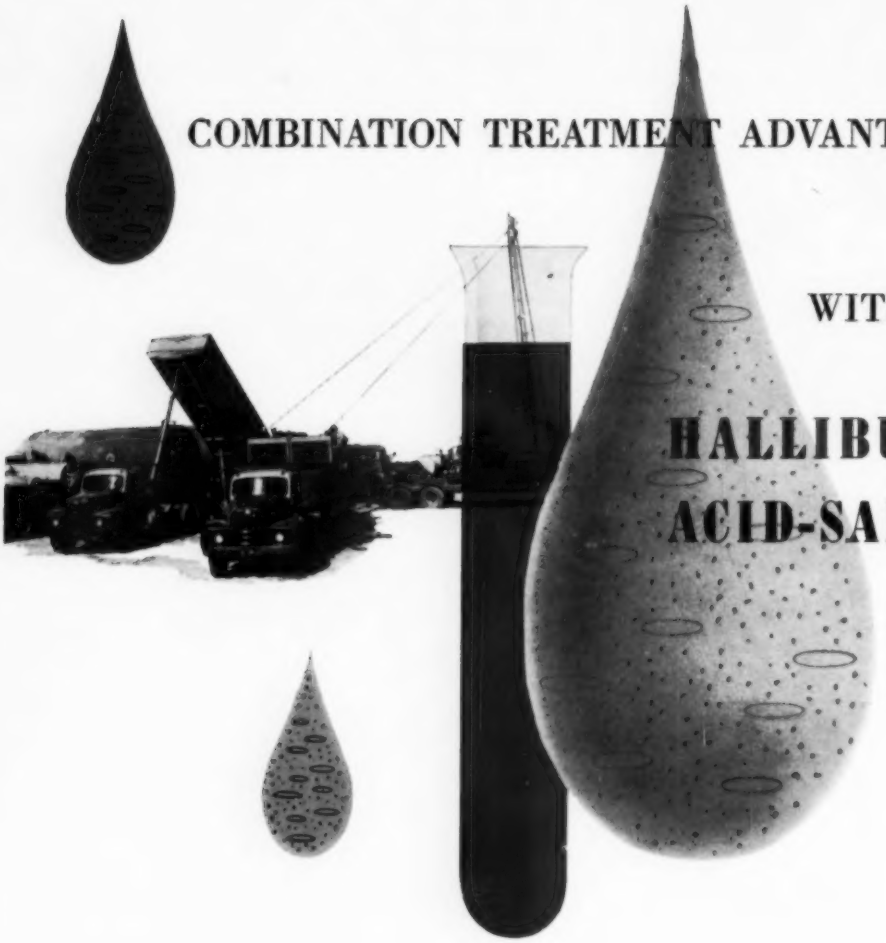
See your J & L Man, or write Cabot for engineering specifications or recommendations.

OIL FIELD PUMPING EQUIPMENT
CABOT
SHOPS, INC.
PAMPA, TEXAS
FRANKS
DIVISION OF CABOT

COMBINATION TREATMENT ADVANTAGE

WITH

HALLIBURTON'S ACID-SANDOIL



Acid-Sandoil, a combination type treatment, was developed for more satisfactory results in certain formations where both acidizing and fracturing methods alone have not proven profitable.

Before the Acid-Sandoil fracturing treatment is applied, a careful analysis of well conditions, as presented by the operator, is made to determine the combination of components required. Field Laboratory tests can aid the well owner in determining the amount and kind of non-emulsifying agent most suitable to meet well requirements.

Successful fracturing has been accomplished by pumping both acid and sand-laden oil simultaneously in selected proportions down the casing... or by pumping acid through tubing and the fracturing oil through the annulus. Excellent results have been obtained with both procedures. The non-emulsifying agents and dissolving power of acid, combined with fracture extension, all work together to create new permeability and to reduce flow restrictions... for more production.

Keep Acid-Sandoil in mind for your wells. Check with your Halliburton Fracturing Specialist.

For more information about all Halliburton fracturing techniques, ask for your free copy of the NEW bulletin, "Elements of Hydraulic Fracturing."

HALLIBURTON FRACTURING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY, DUNCAN, OKLAHOMA

THE PIONEER IN FRACTURING SERVICES

Of Things To Come . . . In Oil

COMPLETE DEPLETION STUDY DUE in coming Congressional year . . . and oil state senators are pushing for it. Lawmakers, such as Sen. Clinton Anderson (New Mexico), contend that best way to fight a tax depletion cut would be to "lay all the cards on the table." Most industry observers admit a "seeming trend" toward eventual reduction of present 27½ percent rate.

INDUSTRY WILL SPEND $3.8 BILLION ON PRODUCTION next year — 11 percent more than in 1958, predicts Pierre Rinfret, speaking at recent AAODC convention. The economist told drilling contractors to expect increase in face of 3 percent overall U. S. industry decrease trend. Rinfret pointed out that oilmen trimmed expenditures too much this year: Off 17 percent from 1957 compared with 2 percent decrease in demand.

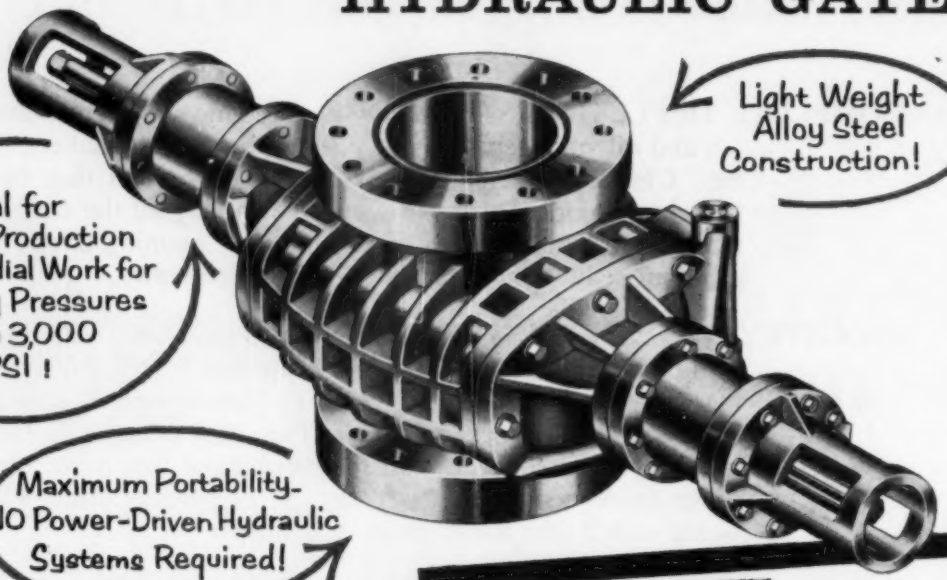
SHALE OIL COMPETITION WITH FOREIGN OIL is seen in not-too-distant future by Union Oil of California, leaders in shale oil research. Union foresees higher foreign oil prices (spurred by increased profit demands by Middle East countries), and lower shale oil processing costs.

VIBRATION DRILLING CAN BE ECONOMICAL in medium-hard rock, but more research will be needed to define limitations and eliminate "bugs." Report on unique method was made by Battelle Institute at ASME petroleum conference in Denver. Vibratory drilling is done by superimposing longitudinal vibrations onto bit of conventional rotary drilling system; frequencies range from 100 to 1000 cycles using a transductor type vibrator. To be economical, vibration methods must triple penetration rates of standard drilling procedures.

NO OFFSHORE BOUNDARY SETTLEMENT for 5 Gulf Coast states for a long time. Federal Government, who had scheduled hearings in its suit to limit state boundaries to three miles, has postponed litigation indefinitely. Government's case hinges around contention that states cannot own land beyond U. S. boundary — which in international circles it claims is three miles. Political implications would be serious in Quemoy, Matsu (between 3 and 10 miles off Red Chinese Mainland) if examiners held Gulf states did have right to offshore properties out to 10½ mile limit.

. . . and ANOTHER Shaffer Advancement!

SHAFFER TYPE LWS HYDRAULIC GATES

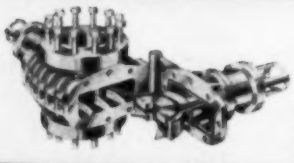


Light Weight Alloy Steel Construction!

Ideal for Drilling, Production and Remedial Work for Working Pressures Up to 3,000 PSI!

Maximum Portability— NO Power-Driven Hydraulic Systems Required!

Sectional View of Shaffer Type LWS Hydraulic Gate Note field-proven "In-Line" construction of each ram and its operating piston.



"Swinging End-Opening" design assures maximum ease in servicing the rams and the ram compartments.

Right on the heels of the recently announced new Shaffer Type XHP Hydraulic Gates for *Extra High Pressure* protection, comes another vitally important Shaffer pressure control advancement—Shaffer Type LWS Hydraulic Gates for new convenience and economy where pressure protection is desired on production, work-over and drilling operations in which portability and minimum rig-up time are important factors.

- Type LWS Gates feature a new type of heavily-ribbed alloy steel construction that combines light weight with adequate strength for the rated working pressures.
- Being light in weight, Type LWS Gates are easy to install and to move about from rig to rig—therefore, are ideal for use on quick "in-and-out" jobs where rig-up and break-down time is vital.
- To further simplify portable operations, Type LWS Gates need not be operated by power-driven hydraulic systems. If preferred, a portable Shaffer Hydraulic Hand Pump—completely self-contained with its own fluid reservoir—is available for operating Type LWS Gates. It will close the rams in from 15 to 20 seconds—fast enough for even urgent pressure emergencies!
- Type LWS Gates feature "Swinging End-Opening" body construction for maximum ease in changing or servicing the rams without loss of operating fluid . . . have positive "In-Line" piston and ram design, with no yokes or complicated connections between each piston and its ram . . . and have many other important Shaffer advancements.

Send for new 12 page brochure that gives full details on Shaffer Type LWS Hydraulic Gates. Or see your nearest Shaffer representative for complete information!

36 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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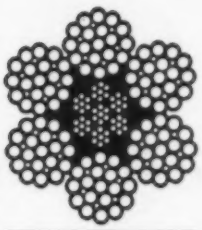
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.



For extra high strength

use

WICKWIRE

DOUBLE GRAY

...save money...increase safety

In many operations where wire ropes occasionally operate near their breaking strength, it will pay you to switch to Double Gray. If you use Double Gray on your present equipment, under equal load conditions, you'll get a safer, more economical operation. That's because Double Gray's higher strength* allows you to operate with a greater safety factor—resulting in longer rope life and less equipment downtime.

***** *Wickwire Double Gray Wire Rope is made of extra-improved plow steel. Fortified by an independent wire rope core of the same extra high strength steel, Double Gray rope has a 15% higher breaking strength than the catalog breaking strength of an improved plow steel rope with IWRC.*

For your free copy of our informative new Double Gray booklet, write to:

Advertising Department
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575 Madison Avenue, New York 22, N. Y.

CF&I

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
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6401

WICKWIRE ROPE
A CF&I PRODUCT

LOOK FOR THE YELLOW TRIANGLE

Another reason why it pays to buy the pipe with the...

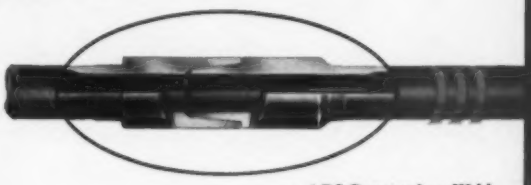
Orange Bands

PERFORMANCE PROPERTIES AND SETTING DEPTHS
LIGHTWEIGHT GRADE E DRILL PIPE

SIZE (OD)	INCHES	2⅞"	3½"	4"	4½"	5"
Weight*	Lb./Ft.	6.85	9.50	11.85	13.75	15.0
Wall Thickness	Inches	.217	.254	.262	.271	.296
Tension Data (Minimum Values)						
Load at Minimum Yield	Lbs.	135,900	194,270	230,760	270,030	328,070
Equivalent Length	Ft.	19,840	20,450	19,480	19,640	21,870
Collapse Data (Minimum Values)						
Collapse Pressure	PSI	8,380	8,080	7,080	6,290	6,140
Setting Depth (S.F. = 1⅛)	Ft.	14,900	14,370	12,590	11,180	10,920
Internal Pressure at Minimum Yield	PSI	9,980	9,600	8,660	7,900	7,830

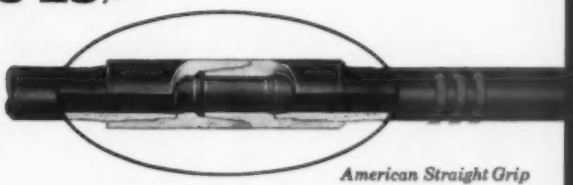
*Tentative API Weights

YOUNGSTOWN LIGHTWEIGHT DRILL PIPE



API Counter-bore Weld

Extends drilling depth, reduces hoisting loads 25% —with your present rig

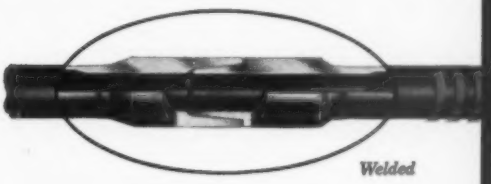


American Straight Grip

Now, Youngstown provides a lightweight drill pipe that will substantially extend your bidding range. You can bid and *get* those deeper drilling contracts—without any changes in your present rig.

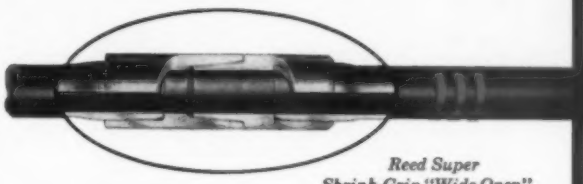
You get more rotating hours with this Orange Band pipe. From ore through final inspection, it is manufactured to rigid drill pipe specifications . . . not a tubing substitute.

On a 10,000-foot hole, a string of 4½" lightweight drill pipe is 18½ tons lighter than 4½" regular drill pipe—because it's 2.85 pounds lighter per lineal foot. This means longer drill strings *without increased weight.*



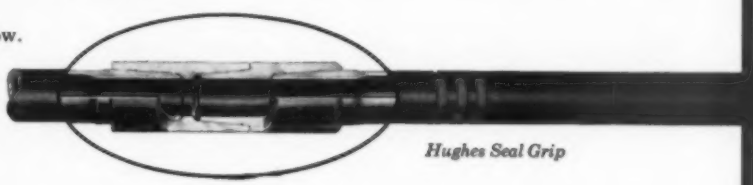
Welded

Since a larger ID is used, hydraulic efficiency (on a 10,000-foot string, 16.7% less pressure drop in drilling fluid column) is improved for longer slush pump rod and bearing life . . . plus a lowering of horsepower requirements.

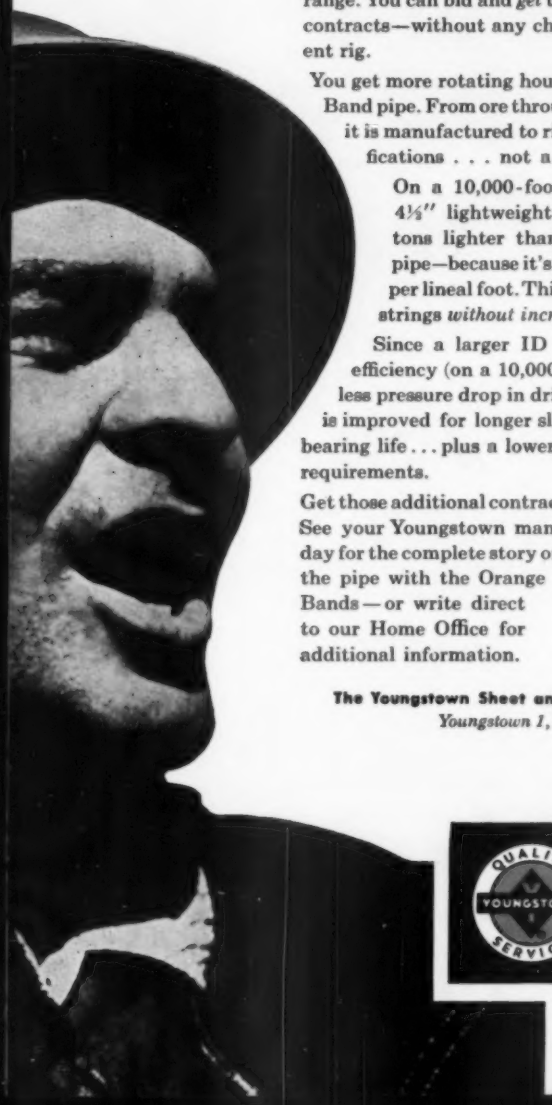


Reed Super Shrink-Grip "Wide Open"

Get those additional contracts now. See your Youngstown man today for the complete story on the pipe with the Orange Bands—or write direct to our Home Office for additional information.



Hughes Seal Grip



The Youngstown Sheet and Tube Company
Youngstown 1, Ohio

Youngstown Lightweight Drill Pipe
Is Available Threaded or Plain End, Internal or External Upset for Attachment with Above Tool Joints.

QUALITY YOUNGSTOWN SERVICE

Youngstown

SEAMLESS DRILL PIPE • CASING • TUBING

No need to tell you...

You need a truck that's suited exactly to the heavy-duty hauling demands put upon your equipment. That's why so many operators like you depend on their Macks for the utmost in available power, minimum down time, ease of maintenance and maximum reliability.

Want a quick reason? No other truck manufacturer makes so many of its components, that work together like a top-notch derrick crew. For instance:

MACK-BUILT ENGINES—gasoline or diesel Thermodynes®. Champions all for long life, dependability and fuel economy.

MACK-BUILT TRANSMISSIONS—up to 20 speeds. Remember that Mack transmissions are built to accommodate power takeoff units necessary for oil-field work.

MACK-BUILT BOGIES—Mack alone builds its own tandem rear ends. Mack Balanced Bogie with Power Divider provides power to the wheels with maximum traction—an important factor in your rigorous operation.

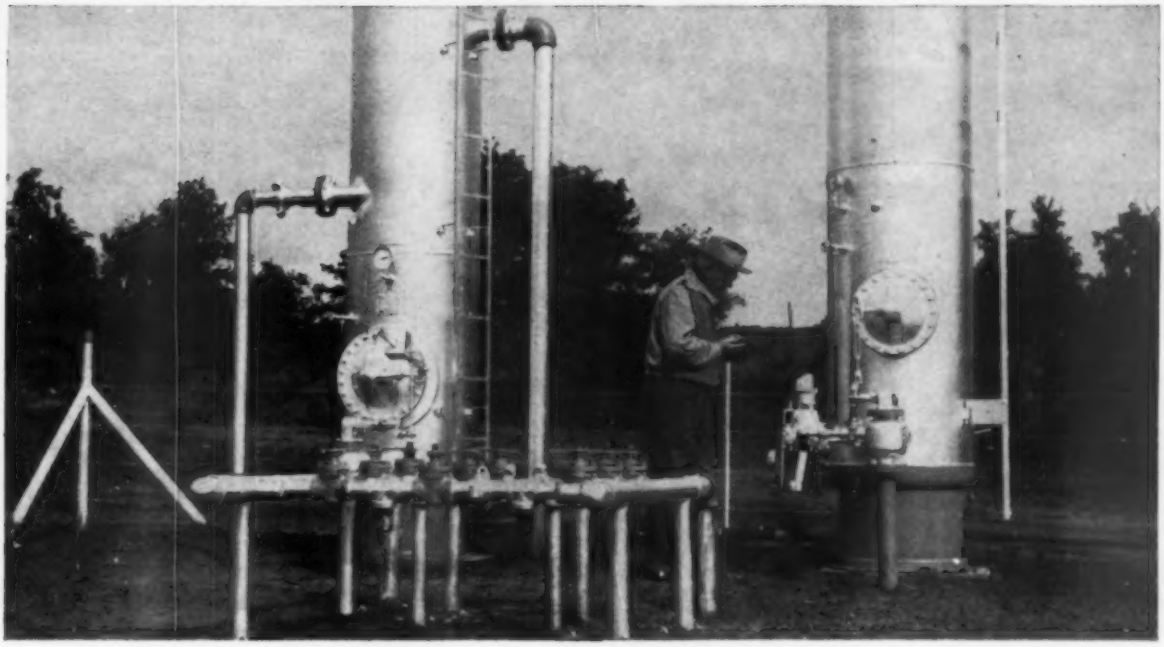
You're short on time, sure . . . but it will only take a minute to call your nearest Mack branch or distributor and ask him to verify these claims. He'll give you the names of Mack users in your own area who can tell you their experience with Macks. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd. 6410

MACK

first name for

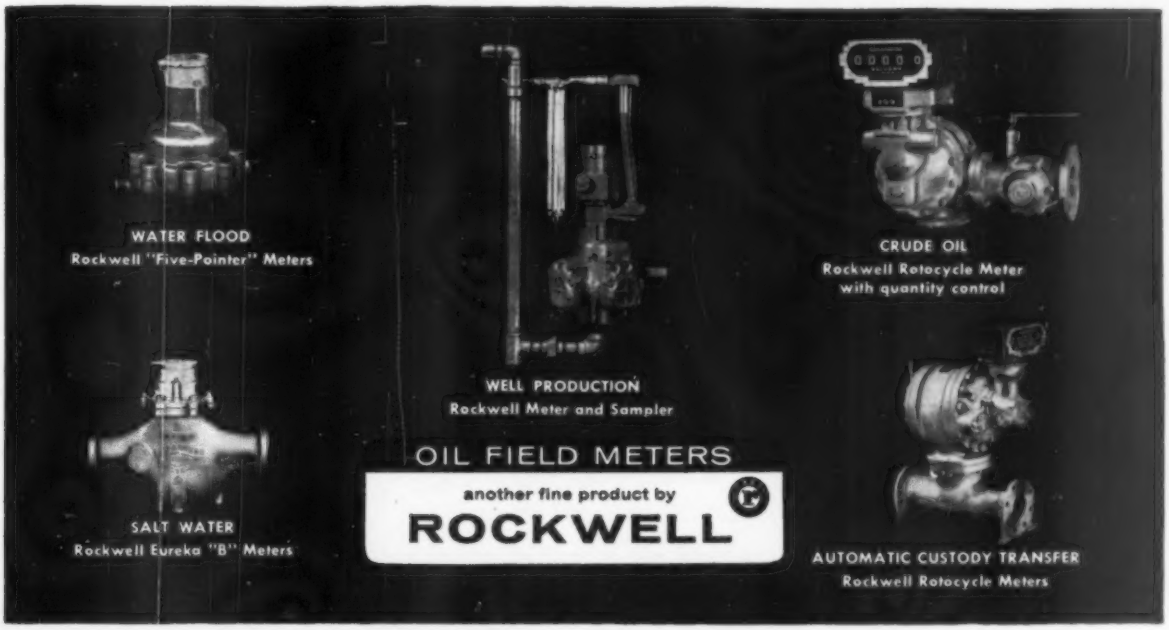
TRUCKS

What do you want to measure?



FOR OIL FIELD METERING ROCKWELL HAS WHAT IT TAKES

Specialized Rockwell meters and accessories answer your needs for every oil field measurement requirement. Whatever the liquid, whatever the service, you can select with confidence from the complete Rockwell line. Accessories including impulse contacters, temperature compensators, etc. are available. For catalogs or help with any measurement problem, write Rockwell Manufacturing Company, Pittsburgh 8, Pa.



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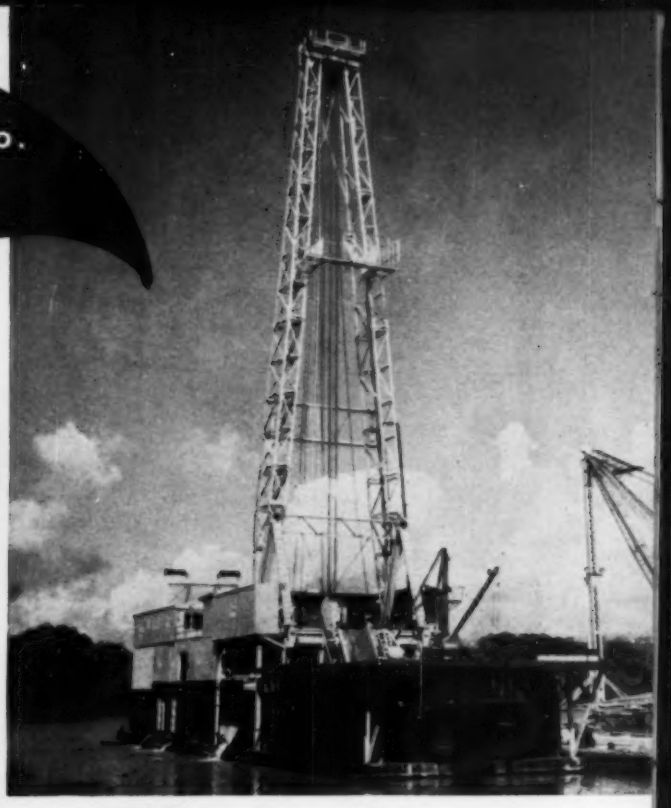
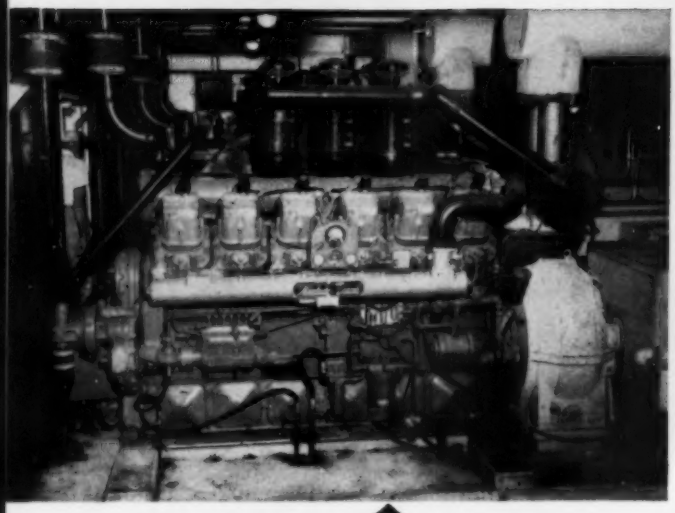
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW Two-R Drilling Co. BARGE No. 1





(drilling engines—drawworks and mud pumps)
Three Waukesha VLRDBSU Turbocharged 12-cyl. Diesels

(rotary table drive and catworks)
Waukesha NKDBSU Turbocharged Diesel

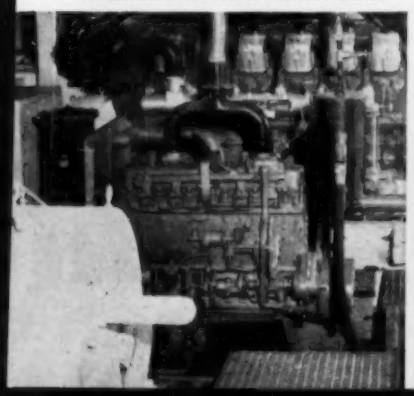
all-WAUKESHA POWERED

Recently commissioned at Morgan City, La., Barge No. 1 has a 25,000′ capacity drilling rig. The mast, 142′ high x 32′ at base, has 1,000,000 lb. lifting capacity. Barge is completely powered by Waukesha Diesel Engines, each of which has its own heat exchanger-surge tank system. The barge itself is 170′ long, 45′ wide, 12′ deep, with a substructure 24′ high; has living quarters for 22 men. It was built for Bethlehem Supply Co. by Reagan Tool Co. for delivery to Two-R Drilling Co. Reagan Equipment Co. supplied the Waukeshas. Get bulletins.

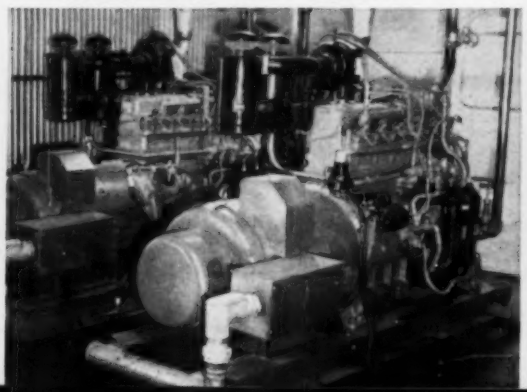
WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN
New York • Tulsa • Los Angeles

396

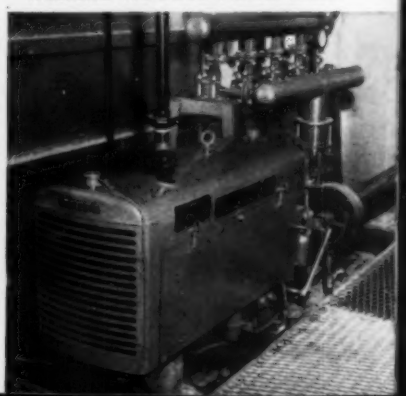
(mud mix pump)
Waukesha WAKDU Normal Diesel



(main electrical power) Two Waukesha WAKDBSU
Turbocharged Diesel 125 KW Enginators



(de-sander unit)
Waukesha 190-DLCU Normal Diesel



MR. H. S. M. BURNS,

President and Chairman of the Executive Committee of the Board of Directors, Shell Oil Company

". . . no factor is more essential . . ."

"From exploration through marketing, the success of oil industry operations depends largely on what the military men call logistics—making sure that what you want is where you want it when you want it.

"Most of us oil men in the United States take it for granted that such matters can be easily handled. Getting supplies and equipment ordinarily involves no more than reaching for the telephone. The reason is that the suppliers do such a good job of maintaining warehouses and effecting deliveries. I suspect that many of us become so used to this that we don't appreciate it properly.

"I learnt appreciation the hard way some years ago when I was involved in developing new oil fields in nearly inaccessible tropical jungle, hundreds of miles from the comforts of civilization. We surely missed being able to handle our supply problems by the phone call treatment.

"The oil industry is complex. Its future success will depend on continued performance by all its members. And no factor is more essential or more likely to contribute to that end than the vigorous, progressive companies that supply petroleum equipment."

P.E.S.A.

* PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

PROUD TO BE PART OF A PIONEERING INDUSTRY

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

THERE IS A DIFFERENCE IN UNIONS -

Look at WECO!

You'll see the difference in their carefully machined seats, the accurately cut Acme threads, the precision machined pipe ends, the deep knurling on the subs that assure safe positive wrenching.

You can't see or feel the rigidly controlled heat treatment but you will know it's there when your WECO Union seats and seals perfectly after hundreds of make-up and break-outs.

Study the design, see how the ball and cone seats always *assure* a positive, full-circle, metal-to-metal seal.

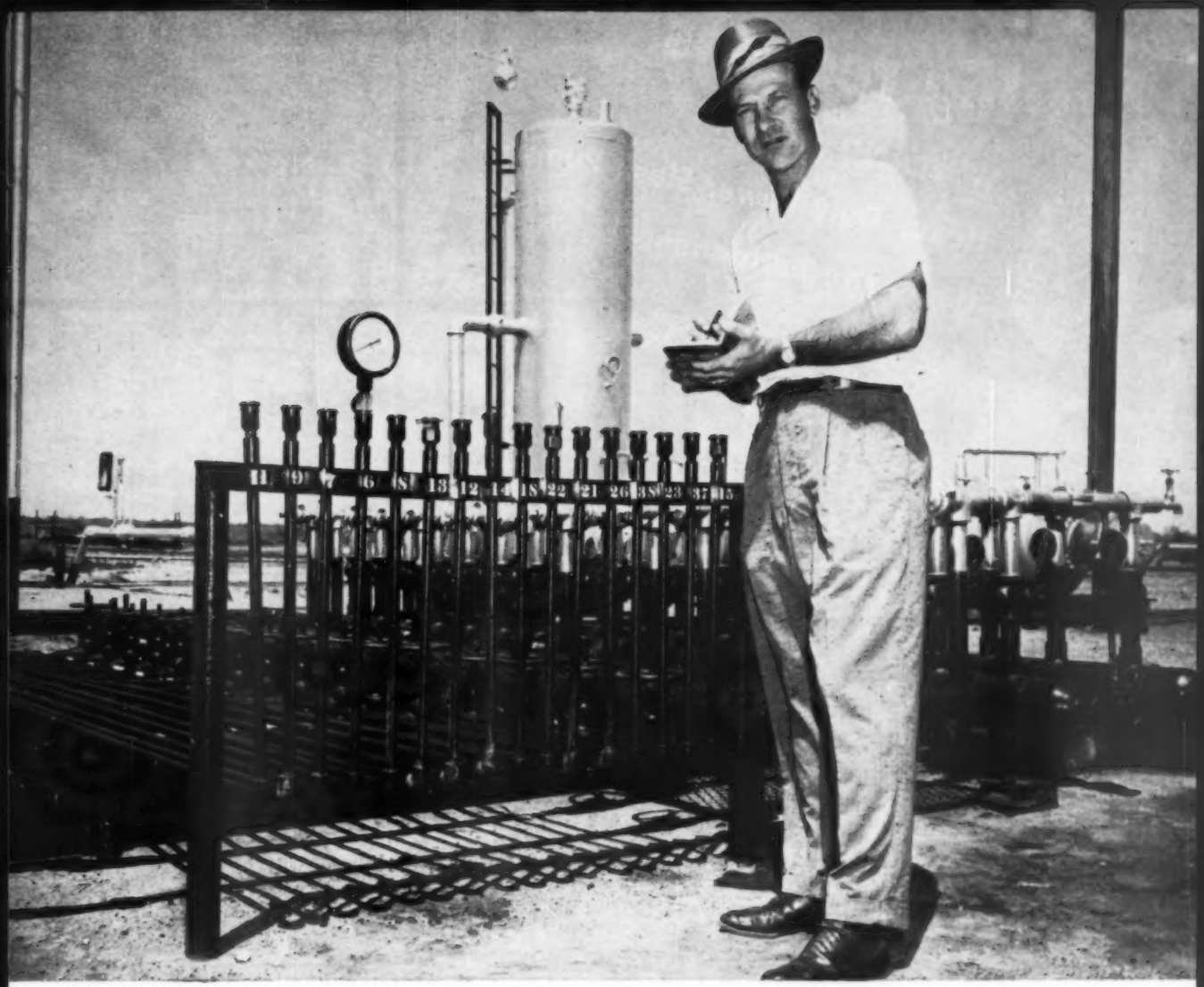
Ask your supply store man about WECO Unions. They are available everywhere in a full range of sizes and pressure ratings. Now is the time for you to standardize on high quality WECO Unions.

U-8-58

WECO®

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

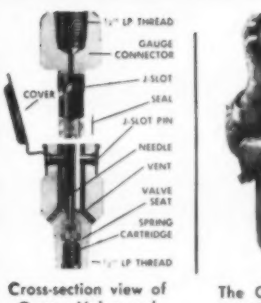
Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION



You Can Stand In One Spot And Gauge Sixteen Wells . . . With One Pressure Gauge . . . in 10 minutes!

It's no trick, and you can do it. Pictured above is a 16-well manifold at a central lease tank battery. Instead of separate pressure gauges for each well, the manifold is equipped with T-C Gauge Valves. A single pressure gauge, with a T-C Connector attached, is stabbed into each Gauge Valve to obtain a pressure reading. Just insert the connector in the valve, rotate 45 degrees, the valve opens automatically, and that's all.

For individual wells, instead of installing permanent gauges on tubing and casing, many operators are now using T-C Gauge Valves and Connectors. The first cost is lower, there's no gauge breakage—gauge repair costs are eliminated—and since the gauges are not exposed to the elements, you can be sure of accurate pressure readings.



Cross-section view of Gauge Valve and Connector.

The Gauge Valve and Connector is widely used on Christmas trees.

THORNHILL CRAVER CO.

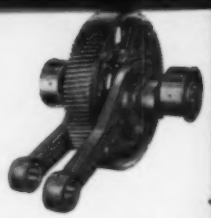
P. O. Box 1184, Houston, Texas

6 big reasons

WHELAND HP-18000 Heavy Duty Power Slush Pumps give extra performance!

Crank

One-piece steel casting heat treated. Compact eccentrics integral with crank give increased throw.

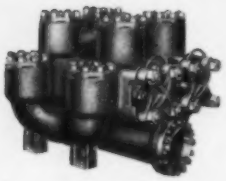


Crank Assembly

Strong and compact. Carburized helical main gear. One-piece steel connecting rods. Roller bearings throughout.

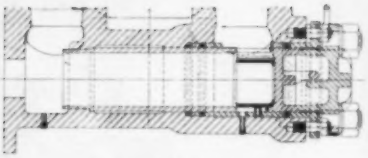
Wheland's Improved (Patented) Cast Steel Pot Covers

Feature metal-to-metal contact and independent gasket adjustment . . . saves time and gaskets.



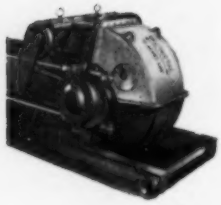
Fluid End

Simplified 1-piece steel casting with low-slung suction pot and short, streamlined fluid passages.



Patented Liner Retainer

and shoulder in fluid end holds liner with metal-to-metal contacts on both ends. Independent gasket adjustment from the outside saves time and gaskets.



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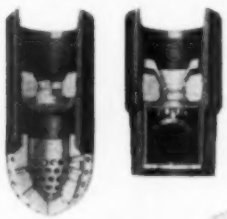

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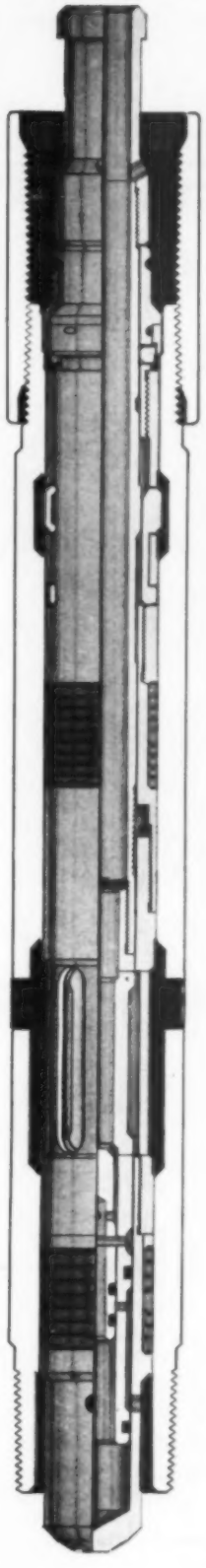

CAMCO

SIDEDOOR CHOKE AND SEPARATION TOOL

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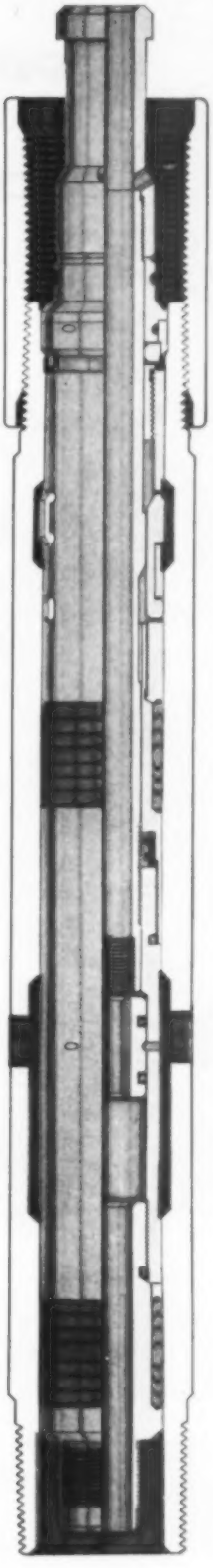

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Beginning a 14-part series in petroleum engineering — presented by engineers and superintendents in operations, research, drilling and natural gas departments of the Atlantic Refining Company:

THE ATLANTIC LECTURES OF THE UNIVERSITY OF TEXAS

INTRODUCTION

Petroleum Engineer: Man with a Future

Vern E. Stepp
Chief Petroleum Engineer
Atlantic Refining Company
Dallas, Texas

Last June, when the production of crude oil was at a low ebb, a close personal friends of mine came to me with a question. He was a college student taking petroleum engineering. He had heard much of the eight-day producing month, the difficulties with imports, possible scarcity of oil in our nation, gasoline wars, and depressed product prices. He was pondering whether he should change his plans . . . whether there would continue to be a healthy petroleum industry in our country . . . whether there would be a continuing need for a petroleum engineer.

One couldn't blame him for asking the question. Any oil man is an incurable optimist. But when one is choosing his career, he wants more than optimism. He wants facts, and he wants to know where these facts will lead him if he becomes involved with them.

But cold reflection does give the oil man, and particularly the petroleum engineer, reason to be optimistic—to have confidence in the future.

Diminishing Demand?

In 1949, the Atomic Energy Commission requested Palmer Putnam to make a study of the maximum plausible demands for energy for the next 50 to 100 years. Putnam has shown that in a very real sense the development of any country or any society directly correlates with its development and utilization of energy. Such is certainly true of our own country. Today our country consumes each day about 9,000,000 bbl of oil and 115 trillion Btu's of energy. The oil industry provides 67 percent of the total Btu consumption. Just 40 years ago, our nation used only around a million barrels of oil per day and 54 trillion Btu's of energy. Oil then provided only 18 percent of the total.

Today the United States uses about 1½ times as much energy per capita as Norway, which has the next greatest per capita consumption, and we use several times as much as the world average.

Oil is an indispensable part of the energy resources of the nation. Research indicated that the United States will need all of its oil resources in the future. Further, it does not appear, from anything now known to man, that such things as atomic energy will replace oil and other currently used energy sources. Rather, it will complement, not replace. Oil has become an excellent fuel for mobile power plants such as automobiles and airplanes. Oil and gas is a wonderful fuel for heating units like those in our homes. It is so cheap that it is widely used even in large industrial applications.

Other energy sources have particular uses and advantages and there will always be a place for them, too. These particular uses will bear upon geographic conditions and size and type of power plant desired. Some experts even have the opinion that oil will become so valuable as a chemical that its greatest demand will come to be from chemical industries and chemical applications.

Oil Availability?

Anyhow, the need for oil in the future will be tremendous and there are many possibilities yet to be pursued to make more oil available to our country. It would be impossible to explore all possibilities fully due to the limitations of time, however, here are a few:

1. The oil below present drilling depths.
2. The oil in remote regions—coastal regions, Alaska, and undeveloped areas of the United States.
3. The oil unrecovered in reservoirs already discovered.
4. The oil to be found in older oil regions by invention of new finding techniques.

Success in these rests squarely upon the engineer. They present an urgent challenge to him.

A Place for the Engineer?

Almost exactly 100 years ago the first commercial oil was produced in Pennsylvania. The first well was drilled by Colonel Drake to a depth of 69 ft. His equipment and his methods were primitive. But consider his problems and what he had to work with. Holes only a few feet deep had been drilled for water. Many of these had been drilled with spring poles using foot power to move the pole up and down. This method was probably used by the Chinese 2000 years ago. By using a steam engine instead of manpower and by using a pivoting beam instead of the spring pole, the oil man had his first cable tool rig. Metallurgy and the fabrication of metals had not developed very far. Steel pipe with adequate threads and couplings was not available then.

Colonel Drake had to use wooden tanks fabricated for his purpose on the spot. He had to move his oil with horse and wagon. He had to devise his own

method of drilling and his own technique for completing the well. Thus his problems were essentially mechanical —i.e., to develop a mechanical means to drill and produce. These same problems have continued until the present day and probably always will exist.

We have now drilled to 25,000 ft, but oil surely lies below that depth and we need to drill deeper. The deepest depth from which oil has been pumped or artificially lifted is about 12,000 ft, but we already have discovered oil below that depth and we need a more economic means of lifting at lower depths. As we drill deeper we encounter higher pressures. Well completions have been made with pressures in the reservoir as high as 16,000 psi and pressure at the surface as high as 12,000 psi. Yet we know that higher pressures exist and we need stronger equipment to control them. Since the day of Drake, 100 years ago, the oil man has had a need to drill deeper and he has needed better equipment and better techniques with which to do it.

We are going to do it—but how? There is the task of the engineer.

Early oil men were so engrossed with these problems that they spent little time in understanding the oil reservoir itself. At the time it was not particularly important for them to know. They knew little of the porous structure of the rock, of the fluids in the rock, or of the movement of the fluids. They simply produced what would come out of the ground naturally and when no more would come out naturally, they moved on looking for another field. They may have suspicioned, but they did not know that when they recovered one barrel of oil they left two behind. And the oil they left behind is still there, to be recovered by methods we are just now devising.

And who is to determine these methods and apply them?—the petroleum engineer, of course.

Since Colonel Drake produced his first barrel of oil, 57 billion bbl of oil have been produced in the United States. It is estimated that about 300 billion bbl were originally in place in the fields which have been discovered and that 30 billion will yet be recovered by primary recovery methods. This means that unless the petroleum engineer can supplement Mother Nature's methods, 87 billion bbl will be recovered from these fields and 213 billion bbl will be left in the ground, that is—2½ bbl left behind for every barrel recovered.

We have developed some secondary recovery methods—waterflooding, underground combustion, miscible phase applications, gas injection, pressure maintenance, etc. But even with these, as far as they have yet gone, it appears that we will still leave more than two of every three barrels that have been discovered. Can we recover these two barrels? Even if we can recover only one of them we will have doubled the ultimate recovery from the fields we have discovered. The day has passed when we can just improve upon what Colonel Drake and his successors have done or when we can study nature's methods and pick the best of them for our use.

New concepts are needed, concepts that can be profitably applied within the limits of economics and costs of our competitive system. They will be developed by the petroleum engineer.

There is a purpose in our presentations. We want to show you cross-sections of our work as engineers and operating people in crude oil operations, to show some of our problems, and what we are working upon to get those additional barrels of oil at a competitive cost.

All these presentations will involve things that are in a stage of development at the present time and will present a discussion of some of these technical frontiers referred to. We have chosen subjects which have a variety of applications to various aspects of crude oil production.

A Journey

We will start with a journey into the Gulf of Mexico. J. B. Harrison, our offshore operations superintendent and L. K. Williams, production engineer assigned to offshore problems, have prepared this article for you. Williams will make the presentation. They have chosen the title "Offshore's Challenge to the Engineer." ★ ★ ★

From classroom to you...

Dr. Paul D. Torrey
Seminar Organizer

Nearly every Monday evening—from September to January—some 200 petroleum engineering students of the University of Texas gather for a senior seminar course called "Frontiers in Petroleum Engineering." The lecture series is unique in that subject material encompasses current research, operational applications and production problems common to the engineer in the field, and that the series are presented by 17 executives, engineers and research men from the Atlantic Refining Company.

Dr. Paul D. Torrey, university special lecturer and seminar organizer, describes the course as an "unusual example of industrial cooperation in the training of engineering talent."

The program, designed to give petroleum engineering students the benefit of field practices as they relate to basic engineering concepts, is under the direction of Dr. George H. Fancher, head of the university's department of petroleum engineering. Dr. Torrey assumes much of the planning and direction of the course.

The series will be delivered by men representing many, many years in industrial training, shedding new light on the future of offshore drilling, the influence of automation and computers in the oil industry, possible new methods of secondary recovery, new ways to combat the multi-million dollar corrosion problem, and many others.

The Petroleum Engineer has been chosen as the only medium whereby these timely lectures may be shared with those outside the classroom. They are complete in every detail, but streamlined for easy reading.

The 14 lectures begin in this issue. Here's what will appear in the months to come:

- Offshore Challenge to the Engineer
- Proration and the Petroleum Engineer
- Applications of Automation in Oil and Gas Production Operation
- Well Logging—Today and Tomorrow
- Tubular Products—Design and Application
- Drilling—1975
- Corrosion—The Holes in Oil Industry's Pocket
- Pattern Sweepout Efficiency—Important Variable in Reservoir Injection Operations
- What to Do About Salt Water
- What is Miscible Displacement?
- Frontier in Reservoir Technology: Reservoir Inhomogeneity Assessment and Control
- Natural Gas—The Slumbering Giant
- Engineering the Profit into Gas Well Production
- The Digital Computer—What It Means to the Engineer

THE ATLANTIC LECTURES OF THE UNIVERSITY OF TEXAS

PART 1

Offshore's Challenge To the Engineer

With only the surface scratched, and lots of room for improvement and expansion . . . this could prove to be the engineer's Utopia

J. B. Harrison and L. K. Williams
Atlantic Refining Company

ACCORDING to Webster's New Collegiate Dictionary, offshore is defined as, "Coming, moving, or directed away from the shore." Common Gulf Coast usage of this term is only a little more specific. Most will agree that it describes an area seaward of a coast line; however, the extent of this area may be to a water depth of 100 ft, 120 ft, or 600 ft contingent on personal experience.

To illustrate this — the geophysicist has explored the area to the 600-ft contour line in the Gulf of Mexico, whereas the operating man has drilled in only 135 ft of water. Each has a different idea as to the limits of offshore. For our purposes we shall not attempt to define the limits of offshore. We have a completely new set of problems once we venture into the Gulf with only the magnitude of the problems changed by water depth.

First, let's look at some history and predictions to help obtain an understanding of its present status and possible extent. The first offshore well was drilled exactly 20 years ago in 1938; 2300 wells later we arrive at July 1, 1958. In between — there has been almost as many man-made problems created by who owns what or who has jurisdiction over where, as the source of the real problems — that veneer of water called the Gulf of Mexico. An industry with less intestinal fortitude might have checked it back long ago.

Approximately 21,000,000 acres have been platted for leasing off of Louisiana and Texas. 4,250,000 of these acres have been leased at one time or other; however, almost half have been dropped such that there was a little over 2,000,000 acres under lease at the beginning of this year. Additional leasing in the foreseeable future is questionable since the ownership problem is yet to be resolved. Also, there is an apparent lack of interest by the industry with existing economic conditions.

The oil industry has paid the staggering sum of $416,000,000 in bonuses to acquire these leases. Lease rentals and royalty payments are not included in the above figure. The Federal Government has been the prime benefactor receiving approximately $246,000,000. Louisiana and Texas have received $122,000,000 and $48,000,000, respectively.

Seventy-seven percent of the 2300 offshore wells from 1938 to July 1, 1958, have been drilled in the past 3.5 years. This effort has been primarily exploratory with the development phase becoming prominent in the last year or so. Development drilling will become more prominent in the future since none of the 124 fields which have been discovered can be considered as fully developed.

The success ratio for exploratory drilling has been a very gratifying 35 percent; the national average is 11

Lots of water, lots of problems, lots of untapped structures with lots of oil — perhaps . . . this is the challenge of the petroleum engineer offshore.

percent. Of course, the exploratory success ratio should be high since we have been drilling on first class prospects almost exclusively. Should it ever become profitable to drill second class offshore prospects, our success ratio will decrease. The success ratio for development drilling has been an acceptable 76 percent. The term acceptable is used, since it is better than average, but not as good as some believe it should be considering the excellent prospects which have been drilled.

Unfortunately, offshore oil production has remained relatively constant at 140,000 bbl per day for the past year. As new wells have been drilled, allowables have been reduced such that average daily production has shown a very slight increase. Gas production has not had to contend with allowable reductions; however, government regulations have presented a very formidable obstacle which has delayed gas reserves getting to market. Present gas production is in the order of 400,000,000 cu ft per day, with a considerable amount of proved reserves yet to start delivery.

Predictions

Now that we have looked at some history concerning offshore, let's take a look at a few predictions. Normally proved reserves, expenditures and revenue don't come under the classification of predictions, but we are going to include them as such since they are ball park estimates. First let's look at proved reserves — it is estimated that they are in the range of 1.5 billion bbl of oil and condensate, and 10 trillion cu ft of gas. To establish these reserves the industry has spent $2 billion and received revenue at $0.5 billion for production to date. To put it more bluntly, the industry is $1.5 billion in the red after 20 years of effort. To equate this rather large sum into something you will more readily understand, it is the equivalent of 250,000 years at your average starting salary.

The figures are impressive; however, they are relatively small when we start looking at ultimate for offshore. Various experts have estimated that ultimate oil and condensate reserves will be from 6 to 10 billion bbl and ultimate gas reserves will be from 40 to 60 trillion cu ft. Reserves for the entire state of Texas as of January 1, 1958 are 15 billion bbl and 116 trillion cu ft. Assuming these estimates are in the ball park and the economics of recovering these reserves is favorable, we can paraphrase that famous Naval expression into offshore language, "We've just begun to spend money."

The Challenge

Herein lies the challenge!

Once again referring to Mr. Webster, he defines this as, "an invitation to engage in a contest." The offshore contest is to find, develop, produce, and transport hydrocarbon products economically such that a reasonable rate of return can be achieved on invested capital.

Prospecting, drilling, and producing hydrocarbons offshore is essentially the same as onshore except for the water environment. That simple statement is extremely deceptive since the connotation of water environment does not get through to the average person the innumerable problems created because of the environment. To carry this comparison further — offshore is in a more difficult position than onshore to compete with foreign production and other fuels — and, as you know, domestic production is taking its lumps now. Offshore is in this difficult position because the ratio of expenditure to revenue is too large under current conditions for the investor to obtain a satisfactory return.

Let's analyze some of the figures we have discussed to justify the above statement. We have pointed out that present producing rate was 140,000 bbl of oil per day and 400,000,000 cu ft per day. This represents an approximate daily net income of $325,000 resulting from a $2 billion expenditure. At this rate, it will require 17 years to recover the investment not considering income tax. This payout is not considered acceptable in industries faced with much less risks. Recent offshore drilling activity is a further indication of offshore's position. In the past year, the number of rigs operating offshore has decreased 56 percent, while during the same period the number of Gulf Coast area rigs operating has decreased only 33 percent.

The Contest

The first part of our offshore contest is to find hydrocarbons. That we have done and can continue to do if we are able to develop, produce, and transport economically. It is an established fact that we, as engineers, must help create a more favorable ratio of expenditure to revenue for offshore to develop as one of the nation's major producing areas.

Obviously there are two conditions which affect the expenditure/revenue ratio — expenditure and revenue. Revenue is affected by the price which we obtain for our hydrocarbon products. There is nothing which we, as engineers, can do about this. That leaves expenditures as the only condition which can be affected by our collective effort.

Regulatory Practices

The realization of relief through reduced expenditures can come about in two general directions. These are (1) modernize regulatory practices to conform with current conditions of technology and economics and (2) develop more efficient methods of development, production, and transportation.

It is a well-known fact that advances

The Authors

J. B. Harrison *is offshore operations superintendent for Atlantic Refining Company at Houston, Texas. A BS graduate of petroleum engineering from the University of Texas, Harrison joined Atlantic as junior engineer in Dallas in 1949 and has since advanced from production engineer, production engineering supervisor, and regional petroleum engineer in both Houston and Dallas. He has served as offshore operations superintendent since 1955.*

L. K. Williams *is offshore district engineer in Atlantic's Houston office. He joined the company in 1949 as an engineer trainee and in 1950 was promoted to production engineer in Houston. In 1951 he was transferred to Dallas as staff mechanical engineer, serving in this capacity until being advanced to his present position in 1955. Williams is a 1949 BS graduate in petroleum engineering from the University of Tulsa.*

have been made in spacing practices and regulations; however, too many wells are still drilled which are not required for efficient drainage. This in turn means proration limitations since the requirement for petroleum products is independent of number of wells. As you can see, this is an unrelenting cycle: More wells — less allowable per well. Fortunately the offshore operator has been able to partially overcome this decrease in well allowable. Most offshore fields are multi-zone which in turn makes multiple completions possible, which in turn lets the operator obtain more allowable per hole drilled. Offshore economics have forced the development of multiple string completion techniques such that multiple string completions are the rule rather than the exception. The CATC group, for example, has completed 26 wells since the first of the year. Of these completions, 6 have been single, 6 have been dual, 13 have been triple, and 1 has been a quadruple. This amounts to 61 completed zones out of 26 holes drilled. With existing conditions multiple completions are essential for economic survival. Allowable administration is another regulatory practice which needs serious consideration. Well reserve, spacing, and cost considerations are needed additions to current allowable formulas.

Cost Picture

Now let's look at possible ways for improving costs of development, production, and transportation. This portion of the discussion has been separated into component parts concerning weather, platform construction, drilling completions and workovers, production, transportation, and corrosion. Each part is given as a separate entity only for convenience since they are not completely separable in day-to-day operation.

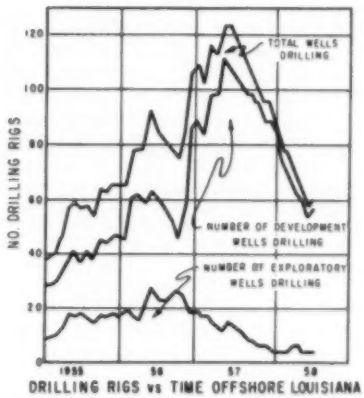
Weather

Probably the most obvious offshore problem evident to the average person is weather. Our position concerning weather has been static for many years, "Everybody talks about the weather but nobody does anything about it." This is an extremely serious problem with which offshore operators have to contend since the vagaries of weather control offshore planning from day to day. This problem is of such magnitude that the operator has been forced to retain outside weather consultants on a permanent basis to keep him continuously informed. He must have this information to properly prepare day to day planning such as boat scheduling, barge and tug movement, rig moves, and equipment installations. Present day weather forecasting is a credit to what it was a few years back and is of tremendous value to the offshore operator, but it is far from being an exact science.

It would be of infinite value if we had the ability to accurately and precisely forecast long range weather conditions. Since we are now up in the clouds with our thinking, let's carry it a step further. It would be of even more value if we could modify or control weather conditions. Imagine what this would have meant to the people of Cameron, Louisiana, last year if "Audrey" could have been modified or controlled!

Platform Construction

Another obvious offshore problem is platform construction. Approximately 200 drilling platforms have been installed to date in the Gulf of Mexico. This represents an expenditure in the neighborhood of $100 million. The first of these platforms were of wharf type construction in relatively shallow water. In utilizing wharf type construction the pile, either wooden or steel, were positioned and driven without a firm guide to a predetermined bearing or penetration. This type pile driving is referred to by the old timers as "Driving them wild," an apt description. The pile were then cut off to grade, braced above the water level, and a deck installed. This type construction obviously has a shallow water depth limitation.



Offshore drilling rigs have seen more active days, as noted on this graph. The overall industry slump in the past 12 months has affected tidelands operations, too.

A different type construction was devised to permit platform installation in deeper water. This method is referred to as the jacket or templet type platform. There are three basic components of this type platform — the jacket or templet, the pile, and the deck section. Each of these components is fabricated ashore for a particular set of conditions, towed to the location, and installed separately. The jacket is installed first and serves two functions (1) it acts as a guide through which the pile are driven and (2) it acts to resist horizontal forces. The pile are then driven and act to support all vertical loading. The deck section is installed on the pile after they are cut to grade and used for placement of drilling equipment and subsequent transmittal of the drilling equipment loading to the pile. The jacket type platform is currently used and has been installed in water depths to 135 ft. We don't know the water depth limitation of the jacket type platform, but it is obviously limited.

Platform design in its present state is a series of exacting calculations using somewhat inexact design criteria. I do not intend to be too critical here since we, as engineers, must do the best with what we have. Platforms must be designed to withstand wind, wave, and dead loading under hurricane conditions. We can establish design requirements for our platforms but we can't accurately predict the forces to which they will be subjected. In a situation like this, our only hope is to build them strong.

The Utopian platform may never make its appearance in the Gulf of Mexico but with serious thinking it will be approached. From a purely theoretical view, it appears foolish not to utilize buoyant forces in platform construction rather than large and expensive man-made energy. The Utopian platform should first of all be designed to withstand known forces, be fabricated in its entirety on shore, be adaptable to towing or floating to the location with all drilling equipment in place, be capable of self-installation or removal with a minimum of external assistance, and be easily adapted for producing operations when drilling is completed.

Drilling

There are three different methods employed for drilling under various conditions. They are the mobile barge, the small platform with tender, and the self-contained platform.

The mobile barge is used primarily for exploratory drilling and development drilling in shallow water. The small platform with tender is used for limited exploratory drilling and development drilling where only a few wells will be required. The self-contained platform is used primarily for development drilling where a large number of wells will be required.

These three methods are used as described because of the economic advantage enjoyed by the different methods under different conditions. The difference exists in the supporting

structure on which the drilling equipment is located. The drilling equipment and procedures are standard for all methods and essentially the same as for onshore.

It is apparent that there is an overlapping of drilling methods, i.e., three tools to do one job — drill a hole in the ground. If the Utopian platform were to be developed, it would automatically combine the better characteristics of the different methods and acquire a universal drilling tool.

Another possibility for a future drilling method is the floating drill ship which has been used so successfully for core drilling off the Coast of California. Core holes have been drilled there in water depths approaching 400 ft with costs comparable to onshore. The big advantage of this type drilling is its usefulness in almost any water depth. In addition, platforms are not required and wellheads are placed on the ocean floor where they are not subjected to storms and collisions with surface vessels. This method has well servicing and production handling problems which are yet to be resolved satisfactorily.

There are a few innovations brought about by offshore drilling. These are the "big-eyed" bit, the "power swivel or sub," and sea-water mud.

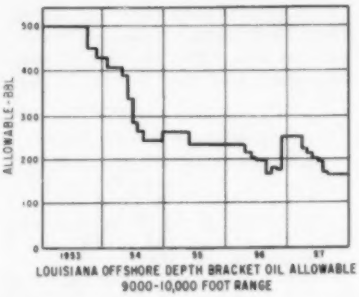
"Big-eyed bit." As you know, only one straight hole can be drilled from a platform. The remaining holes must be drilled directionally. Directional drilling is controlled with a tool called a whipstock. The whipstock does an admirable job except that three round trips are required for each whipstock setting. To overcome this drawback, the "big-eyed" bit technique has been developed. With this technique one of the nozzle inserts in the bit is made much larger than the other two. Since the larger nozzle will pass much more of the mud stream than the other two, it will wash the hole out in the direction it is pointing when the bit is held stationary. In this manner it is relatively simple to orient the bit and wash the hole off vertical in the desired direction. A round trip isn't necessary after the hole has been deviated since the bit is satisfactory for subsequent drilling.

The "power swivel or sub" is actuated hydraulically and is used to replace the conventional rotary. With this tool a 90-ft stand can be drilled without making a connection. This saves 2 of 3 connections when compared with the norm of adding singles as hole is made. Another advantage is the ability to "drill upward" as well as down. This should help prevent many cases of pipe sticking.

Sea-Water Mud. Water everywhere but not a drop to drink or drill with has been descriptive of offshore. It isn't too difficult to provide drinking water but the drilling rig has a considerably larger appetite. Providing for fresh drilling water is quite expensive since it is necessary to haul water over large distances and then provide storage for it on the platform. Sea-water muds have been used in the past but until lately haven't been too satisfactory. Recent advances have made sea-water muds acceptable and with additional time and effort they should enjoy popular usage.

Completions and Workovers

Closely associated with drilling are completion and workover problems for it is imperative that offshore wells be completed in a manner to secure the longest possible life. This requirement is necessary since workover costs at the present time are exhorbitant. It is estimated that the average offshore workover cost is equivalent to the drilling cost of a 7000 ft onshore well; therefore, we must keep workover frequency at a minimum.



Total production from offshore wells has remained constant for some time, although the number of producing wells has increased — with one result: Lower allowables.

Offshore completions are similar to onshore except that more emphasis is placed on obtaining a trouble-free completion. This emphasis has been even more pronounced recently with the wide acceptance of multiple string completions. Trouble-free completions are dependent on two factors (1) reservoir and (2) mechanical. From a reservoir standpoint, we attempt to complete such that water, gas, and sand will not intrude prematurely.

These attempts are not always successful, particularly in regard to sand intrusion. A completely acceptable sand exclusion method has been a prime object of industry research for many years. From a mechanical standpoint, the attempt to install completion equipment which will remain serviceable until the producing zone is depleted has not always been successful — primarily because of corrosion and loss of pressure control through tubular goods or packing mechanisms — loss of pressure control is commonly called communication.

Because of this lack of success, such that wells will not be trouble-free for normal producing life, workovers are required periodically to maintain productivity. This same problem is faced on land; however, specialized workover equipment for any remedial work is readily available at a nominal cost. This specialized service is not available offshore since workover requirements at the present time will not support specialized equipment. Unfortunately, many workovers are performed with a drilling rig capable of drilling to 20,000 ft that could be handled on land with a simple pulling unit. Unquestionably, specialized workover equipment will be evolved but it will require sound thinking to develop adequate, easily transportable, yet economical equipment.

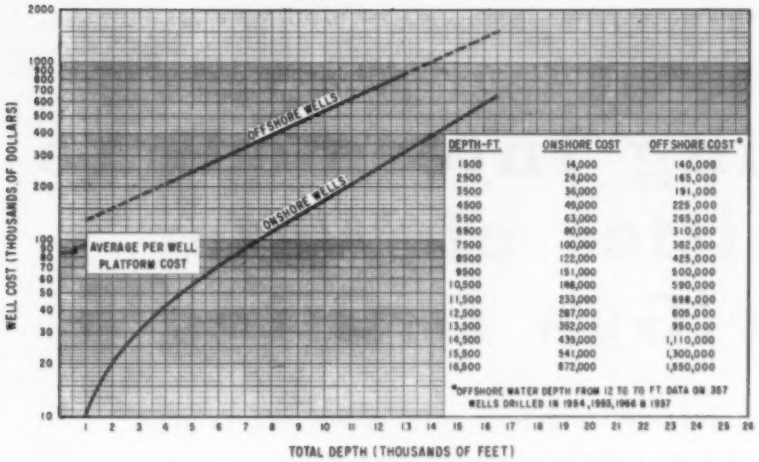
The thinking discussed above arbitrarily assumes that workover rigs are required. This is the practical approach. We can get up on Cloud 9 and say that the permanent type completion technique will be perfected that justifies the name. Permanent-type or through-tubing completions and workover techniques are being continually improved and are effecting considerable savings as compared to conventional workovers; however, "permanent" is not an accurate description. It would be of infinite value to the industry if it were.

Production

Producing equipment used offshore is the same as onshore except that it is a little more over designed capacity-wise, utilizes more safety controls, and must be installed in considerably less space. This is to be expected since we are using the equipment to do the same job; however, there are some disadvantages which are not apparent with onshore usage. The two more prominent examples are (1) fired vessels and (2) product storage vessels.

Fired vessels such as heaters, treaters, and reboilers, do not present a safety hazard onshore since there is practically unlimited area in which they can be placed at a safe distance from tank batteries. Obviously, the same does not hold offshore. To overcome this deficiency of distance fired vessels can be placed on separate platforms — which is quite expensive — or install them on the same platform with every safety control available — which may be even more expensive should there be a fire. This problem would be nonexistent if techniques were developed to do the same jobs with unfired vessels.

Product storage presents a considerable problem if pipeline facilities are not available and they will only be



Offshore well costs are considerably higher than onshore costs, as attested to by Louisiana statistics. The 16,500 ft well onshore cost $672,000; offshore, the cost leaps to $1,550,000.

available to major fields. The problem arises since there must be sufficient storage to prevent allowable loss during bad weather periods when barges cannot run — approximately 10 times the daily production is required for storage capacity. In other words, if we had a daily productivity of 2500 bbl, we would need approximately 25,000 bbl of storage. Storage requirement has a direct relation with platform deck area requirement and deck area is quite expensive.

A possible solution is the utilization of underwater storage. This approach has been kicked around for some time and is feasible. A novel idea recently made public is the utilization of large rubber or plastic tanks for storage. With this installation, rubber or plastic tanks of required capacity are placed in an open type frame ashore. The entire unit is towed to the location using air in the tanks for floatation. The unit is sunk at the location adjacent to a platform by venting the tanks and is secured to the ocean floor with stub pile. The tanks are filled by pumping into them and emptied by simply opening a valve. The differential head between sea water and oil will force the tanks to empty without external means.

Automation of offshore producing equipment should be a natural. The purpose and payout of automation is realized through less manpower for a particular job or series of jobs. When manpower offshore decreases, it does more than decrease labor costs. Offshore labor must have attendant boat, galley, and quarters services which are several times more costly than the labor itself.

Transportation

Transportation requirements for offshore operations present a formidable obstacle to be overcome. For those who gained primary education onshore, it has been particularly troublesome. The tempo of doing things offshore is dependent on transportation and there is a considerable difference between the use of a boat by a number of people and the individual use of a car or truck.

The prime moving facility for materials and personnel has been the boat. Within the past couple of years or so the helicopter has made inroads on personnel transportation and is widely used where there is a large concentration of personnel. The helicopter has a hard time competing economically at remote and scattered locations. Because of the high fixed cost of helicopters, they must stay busy to compete. Boats are used almost exclusively for material transportation because of their relatively large pay load as compared to helicopters. In addition they are not as weather sensitive.

The principal transportation problem concerning materials and personnel is to get them where they are going in time. This is not too difficult in good weather but in foul weather it's another story. It can become quite tedious if a well is about to blow-out, mud supplies are low, and weather won't permit supply boats to run. Personnel morale and efficiency are affected in a like manner.

Product transmission is accomplished by pipeline, barge, or small tanker. Pipelines are the most important of the facilities since they will transport both oil and gas.

The largest line installed to date is a 26 in. line just recently completed which is being used to transport both gas and condensate. The design of a line for two-phase flow, such as this, creates an engineering problem which is yet to be solved completely. The problem is to determine pressure drop in a two-phase system to size lines accurately. At best, present procedures of calculating pressure drop are only a good approximation and additional knowledge is needed in this field.

Barges and small tankers have been used to transport liquid products from fields which could not justify pipelines. Small tankers have a difficult time competing with barges because of their high fixed cost and their future utilization is limited. Although boats and barges have been used by man for several centuries, the oil industry has a special usage for them. It is not unreasonable to expect continuing improvements in their performance.

Corrosion

Our offshore corrosion problems are universal since they apply to all phases of operation. Corrosion prevention practices offshore can be divided into four categories — atmospheric, splash zone, under water, and in-hole. These categories are self-explanatory except for possibly the splash zone. This zone is the area from approximately −2 ft mean Gulf level to + 8 ft mean Gulf level which is alternately wet and dry due to tide and wave action. This is the most difficult zone to protect. Each of the different categories requires a special prevention practice for adequate control. The advantage of a corrosion prevention technique which could adequately control all categories is apparent.

Self-Examination

This discussion has been very critical and even derogatory in some places.

Actually, the preparation of this article has afforded the opportunity to make a critical self-examination.

Let's reconsider a few of the things which have been discussed. First of all, the Gulf of Mexico covers a lot of hydrocarbons which are not as economically attractive as they should be. Possibly the main contributing factor to this is that offshore is an infant as compared to onshore and with insufficient time to evolve optimum methods. A part of the problem may be that we are attempting to modify onshore operations to fit offshore when we should be aproaching it from a completely fresh viewpoint. In either case, offshore will approach Utopia for the engineer since the opportunities for improvement are infinite as compared to anything else in the oil industry. I am convinced the challenge of finding, developing, producing, and transporting hydrocarbon products economically will be met by our collective thinking and critical self-appraisal. ★ ★ ★

Development of foaming agents continues for use in . . .

Combatting Intermediate Quantities of Water In Air/Gas Drilling

Laboratory and field tests prove effectiveness of new foaming agent, permitting air and gas drilling with water influx up to 60 bbl per hr

B. V. Randall,
J. L. Lummus,
and
R. P. Vincent
Pan American Production Company
Tulsa, Oklahoma

THE PRINCIPAL DETERRENT to expanded use of air or gas as a drilling fluid has been the problem of controlling the influx of water into the well bore. This problem may be divided into three parts; (1) small quantities in so-called "weeping" formations, (2) intermediate quantities, and (3) excessive quantities which, from a practical and economical standpoint, generally dictate conversion to conventional mud drilling.

Injection into the air or gas stream of dry, finely ground stearates, which impart a water-repellent film on bit cuttings, has been found effective for preventing balling of cuttings in the presence of small amounts of water. These antiballing agents also effectively reduce friction and in several instances have permitted continued drilling in the presence of up to two barrels of water per hour.

When water influx is more than about two barrels per hour, this method becomes impractical and water and cuttings must be removed by an alternate method. If sufficient air or gas is available at high enough pressure, water and cuttings can be blown out of the well bore; however, since this gas lift design is anything but ideal, its efficiency might be as low as five percent. This low efficiency, together with the friction losses in a long string of pipe and a rough annular space, make it economically impractical to lift water from any but the most shallow holes by this method.

The results of field tests have demonstrated that use of a foaming agent is an effective means of removing intermediate quantities of water, i.e., from 2 to 60 bbl per hr, and bit cuttings from a well bore. The ideal foaming agent would enable air or gas to remove water and cuttings from a well bore effectively, would lubricate the cuttings to prevent balling, and would prevent the formation of destructive high-speed slugs of water.

Laboratory Evaluations

Laboratory tests consisted of the determination of static and dynamic surface tensions, film thicknesses, and film drainage rates by conventional methods using dilute aqueous solutions of various foaming agents. Tests of potential foaming agents were made in a model well. Solutions to be evaluated were placed in the well and air introduced at a known rate. The rate of foam rise, the volume of foam produced, the weight of cuttings carried out, and the volume of liquid carried out were measured. These results were used to calculate water carrying capacity, cuttings carrying capacity, foam producing ability and stability under various rates of shear. Materials were evaluated in the presence of many types of cuttings, various brines, oils and other possible contaminants. Additional tests were made in an 800-ft cased hole under various operating conditions including back pressure simulating conditions down to 18,000 ft. Actual drilling tests were also made in both limestone and water sensitive shale formations.

Field tests of foaming agents were conducted in wells being drilled with air or gas where water flows were expected to exceed approximately two barrels per hour. Where possible, a flow meter, a chemical feed pump, and a gas driven water pump were connected to the high-pressure air or gas supply line (below). When water was encount-

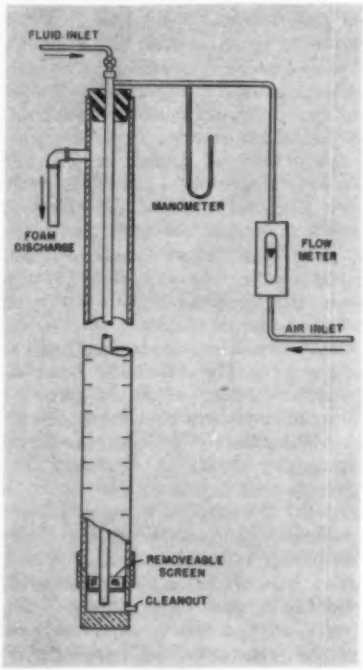


Diagram of model well used in laboratory tests of various foaming agents. Tests permitted determination of foam-producing rates, foam stability, water-handling capacity, and cutting-carrying capacity.

Adapted from paper entitled "Combatting Wet Formations While Drilling With Air or Gas" presented at the 18th Annual Meeting of the American Association of Oilwell Drilling Contractors, October 1-3, 1958, Dallas, Texas.

ered in the well bore a foaming agent and additional water were injected at various rates and the quantities of fluid flowing out the exhaust line as well as the effects on circulating pressure and drilling conditions were observed.

Test Results

Model well tests conducted in the laboratory indicated that an excellent foaming agent is one which reduces the surface tension to about 40 percent of its original value. The tests also indicated that the surface tension of the foaming agent can be too low. Experimental Agent F, which reduced the surface tension to approximately 30 percent, produced such weak films that a stable foam could not be made. These results are shown in Table 1. The results of tests to determine the effectiveness of various surfactants as possible foaming agents for use in air or gas drilling are shown in Table 2.

One surfactant, *Synfoam No. 1**, was found superior to other foaming agents tested for removing fresh water, or brines containing up to five percent salt and cuttings. Tests in model wells in the 800-ft, 10-in. cased hole under various conditions showed that this agent would lift water and cuttings in the presence of all types of contaminants except an excessive amount of salt. It was also indicated that this material would be effective under conditions simulating an 18,000-ft well, and would perform satisfactorily at air or gas velocities ranging from 2 to 7000 ft per min.

Subsequent laboratory work resulted in development of a modification of Synfoam No. 1 which is effective in all types of brines, as well as in the presence of any common contaminants. This material has been designated as Synfoam No. 2. Further tests showed that both of these compounds become increasingly effective relative to other foaming agents in the presence of high concentration of pulverized cuttings, particularly clays or shales. They may be used with either lime or organic corrosion inhibitors to reduce corrosion when air is the circulating fluid.

The results of field tests of the unmodified agent on five wells are shown in Table 3. Details of these tests are described in the appendix. The tests show that the foaming agent will effectively remove intermediate quantities of water per hour while drilling with air or gas. This intermediate range of water flow which can be effectively controlled with the foaming agent appears to be from 2 to about 60 bbl per hr. In comparative tests, this agent was found to be more effective than a number of other foaming agents in brines containing up to five percent salt and in waters containing calcium sulfate. The tests showed that in instances where the volume of air or gas was not sufficient to circulate water and cuttings from wells, addition of the foaming agent was effective in regaining circulation. In the field test on Well No. 2, Eddy County, New Mexico, the new foaming agent and water were used to lift bit cuttings because the quantity of gas available was too low for removing cuttings.

The results of the field tests on Well No. 1, Rio Arriba County, New Mexico, and on Well No. 3, Lea County, New Mexico, indicated that the foaming agent could be used to maintain gas drilling at an economical rate, whereas without foam it would have been impossible to drill without converting to conventional drilling mud. No field tests have as yet been made of the modified foaming agent.

Anionic and Cationic Agents

A number of commercial foaming agents and surface active agents were tested in the laboratory. The following general results were observed: The agents listed in the literature as the best foamers are generally anionic. Some of these excellent foamers for shampoo or dishwashing formulations are completely destroyed under well conditions. Anionics with satisfactory

*Trademark, Swift & Company.

TABLE 1. Effect of Surface Tension on Water Removal Properties of Foams.

Agent	Concentration %	Surface tension against air dynes/cm	Water capacity bbl/hr/1000 CFM
Water	(Reference)	72.0	0
Commercial Agent A	0.01	32.3	77
Commercial Agent R	0.01	29.7	96
Commercial Agent G	0.01	29.0	106
Synfoam No. 1	0.01	27.6	141
Experimental Agent F	0.1	21.9	0

TABLE 2. Model Well Foam Test Results.

Agent 0.07 lb/bbl	Foam producing rate in./sec.	Stability sec.	Foam index in.	Water capacity bbl/hr/1000 CFM	Cutting carrying capacity lb/hr/1000 CFM
Synfoam No. 1	3.0	137	411	141	170
Commercial Agent A	1.7	140	238	77	150
Commercial Agent G	2.1	115	242	106	10
Commercial Agent R	1.5	167	251	96	30
Experimental Agent E	2.5	59	148	73	40

TABLE 3. Results of Field Tests of Foaming Agents.

Test No.	Area	Depths (ft)	Results
1.	Rio Arriba County, New Mexico	4958–5984	Removed mud rings, maintained full cuttings return, penetration rate equal to dry section of hole.
2.	Eddy County, New Mexico	645– 884	Removed cuttings at gas velocity of 900 ft/min.
		3820–3914	Removed cuttings and up to 30 bbl of oil/hr.
3.	Lea County, New Mexico	6200–8038	Removed cuttings and 15 bbl of brine and 1 bbl of oil per hr.
4.	Eddy County, New Mexico	95	Removed rings, regained air and cuttings circulation.
		2122	Removed 90 bbl of water per hr.
5.	San Juan County, New Mexico	4230–4865	Removed rings, cleaned out workover well.

TABLE 4. Amount of Synfoam No. 1 Recommended to Remove Water and Cuttings.

	Synfoam No. 1 recommended, lb/hr			
Water produced bbl/hr	Type of fluid: Fresh water less than 1% brine	5% brine	13% brine	Saturated brine or oil present
10 or less	2	3	7	14
20	4	6	14	28
30	6	9	21	42
40	8	12	28	56
60	12	18	42	84
80	16	24	56	112
100	20	30	70	140

foam stability are adversely affected by brine or hard water. Although cationic surface active agents are tolerant of brines, they are very strongly adsorbed on bit cuttings and can become completely inactive in the presence of pulverized solids. Nonionic agents are less strongly adsorbed on cuttings and are not as sensitive as anionic agents to contaminants such as sodium chloride and calcium sulfate.

The primary purpose of using foaming agents for removing water and cuttings from a well is to allow continued drilling with air or gas, which, even under wet conditions, is a faster drilling fluid than water or mud. An analysis of field tests and information obtained from operators and service companies has indicated that foam drilling can be accomplished economically if the amount of water production does not exceed approximately 60 bbl per hr. This upper limit on the quantity of water that can be effectively removed with foam is an arbitrary one but has proved useful in determining whether to continue air or gas drilling or convert to conventional drilling mud. Data in the appended case histories also tend to support this approximate upper limit. For example, in the field test on Well No. 4, Eddy County, New Mexico, the surface and intermediate hole was drilled without difficulty using additions of foaming agent and water to remove damp cuttings and a small amount of water from the hole. However, a water influx estimated to be 250 bbl per hr was encountered below the intermediate casing point which could not be efficiently removed with the limited quantity of air available at the well location. The cost of additional compressor capacity and foaming agent to remove this quantity of water was considered to be prohibitive.

In Well No. 3, Lea County, New Mexico, foaming agent was used to remove approximately 15 bbl of saturated brine and 1 bbl of oil per hr while drilling the interval from 6200 to 8038 ft. 169 rotating hours and 16 bits were required to drill this section as compared to 275 rotating hours and 20 bits for a nearby well drilled with mud. Savings in rig time and bits over the interval studied were estimated to be approximately $10,000.

The foaming agent is generally mixed in 10 bbl of water and pumped into the air or gas line on the high-pressure side. The quantity of the foaming agent incorporated into the 10 bbl of water being injected per hour is varied depending on the quantity and salt content of the water being produced. Reference to Table 4 shows, for example, that in order to remove efficiently 20 bbl per hr of fresh water from a well would require injection of 4 lb per hr of the foaming agent. Injection of 8 lb of the foaming agent per hour would be required if this quantity of produced water contained approximately 8 percent salt.

Indication of Water Influx

When an intermediate quantity of water is encountered, the dust flow stops suddenly and a "drilling break" and an increase in circulating pressure may be noted. About five pounds of foaming agent with one to five barrels of water should be added, and as soon as circulation is established, drilling may be resumed while the water flow rate is determined. Foaming agent and water additions should be the smallest quantities which will produce constant circulation and a low even circulation pressure in order to achieve maximum penetration rate while maintaining chemical costs at a minimum.

It is concluded that use of a nonionic foaming agent is an effective means of removing intermediate quantities of water, i.e., from 2 to about 60 bbl per hr, from a well bore. Also, use of a foaming agent has made it possible to continue air or gas drilling in several wells which resulted in faster drilling rates than would have been obtained using conventional drilling mud.

APPENDIX

Case Histories on the Use of Foaming Agents

Well No. 1, Rio Arriba County, New Mexico

In this well a 6¾-in. hole was being drilled with approximately 1500 cu ft per min of natural gas as the circulating fluid. At a depth of 4917 ft a small water flow was encountered which caused the flow of dust to stop. Normal practice of blowing the hole dry and drilling ahead was used for 11½ hours to drill to 4958 ft. At this depth mud rings in the hole had started causing excessive drag on the pipe and reducing the gas flow.

As soon as it was apparent that normal gas drilling could not be continued, 4 lb of foaming agent in 10 bbl of water were injected; this treatment removed the mud rings and wet cuttings which had accumulated in the hole. The average treatment required to maintain a consistent foam while drilling was found to be approximately 1.4 lb of foaming agent in 7 bbl of water per hr. This treatment was used to drill the interval from 4958 to 5984 ft in 28½ hr drilling time. One trip was made during this interval and the hole found to be open and free of cuttings. Because of mechanical difficulties, total time to drill the 1026 ft with foam was 55 hours. During preparations to make a trip from 5984 ft the Mancos shale sloughed and stuck the pipe. Drilling mud was pumped into the well in the process of freeing the drill string.

Results of this test showed that foam can be used to remove wet cuttings while drilling, and that penetration rates obtained were similar to those obtained with dry gas; however, shale which sloughs when penetrated with clear water should not be exposed to foam.

Well No. 2, Eddy County, New Mexico

A 16-in. surface casing was set at a depth of 785 ft. No bridge plug was used in displacing the cement and wet unconsolidated cement was found at 645 ft. Gas rates in the range of 1025 to 1840 cu ft per min were used to drill a 13¾-in. hole. The foaming agent was injected at the rate of 15 lb per hr while drilling to a depth of about 800 ft. Addition of about 20 bbl of water as well as foaming agent was required to drill to 884 ft. At this depth additional gas required to lift cuttings was obtained and the hole was dried up using calcium stearate as an antiballing agent.

At a depth of 3820 ft an oil sand was penetrated and only partial returns could be obtained with as much as 50 lb foaming agent and 20 bbl of water per hr. Drilling was continued to 3914 ft. At this point it was estimated that low gravity oil was being produced at the rate of 30 bbl per hr. An emulsion of brine and oil was blown out of the hole for 14 hours by additions of 10 lb of standard foaming agent, 40 lb of a salt water foaming agent and 20 bbl of water per hr. Failure to add any one of these materials was indicated by cessation of flow of the crude oil emulsion from the well within five minutes. At this point it was apparent that the oil flow could not be economically overcome and the system was subsequently converted to a conventional water base mud.

The results of this test indicated that foam can be used to remove cuttings when air or gas velocities are too low for normal air or gas drilling and is effective for removing small quantities of produced oil.

Well No. 3, Lea County, New Mexico

Gas was being used as a circulating fluid to drill a 9⅝-in. hole when water was encountered at a depth of 6200 ft. Additions of foaming agent allowed gas drilling to continue, and the well was drilled to 8038 ft in 16 days. The average well production was 15 bbl of brine and 1 bbl of oil per hr. Water production appeared to be from zones above 7500 ft; therefore, an attempt was made to keep the bottom of the hole

dry by using a salt water foaming agent in flake form to foam the water above the water-bearing zones. This procedure was unsatisfactory because the bottom of the hole could not be kept dry. The most economical treatment to keep the hole free of cuttings was found to be 2 lb of foaming agent, 1 lb of refined calcium lignosulfonate, ¼ lb of caustic soda, and 10 bbl of water per hr. The results indicate that refined calcium lignosulfonate and caustic soda additions stabilize foam produced by the foaming agent when the produced water contains salts such as sodium chloride, calcium chloride, and calcium sulfate. At the depth of 8038 ft a large decrease in the gas supply forced gas drilling to be abandoned.

Results of this test showed that the use of foaming agent would allow gas drilling to continue while water and oil are flowing into the well bore.

Well No. 4, Eddy County, New Mexico

The 11-in. surface hole was air drilled below 38 ft of 13⅜-in. conductor pipe. At a depth of 65 ft damp hole conditions decreased the return of cuttings and at 95 ft the return air contained no cuttings and had 100 percent humidity. When an attempt to pick up the pipe was made, it stuck at a depth of 75 ft and air circulation was lost. Approximately 20 bbl of water and 4 lb of foaming agent were added to the air line during a 30-min period while the bit was slowly lowered back to bottom. Thick foam, mud cake and mud balls were circulated out of the hole. The hole was clean and was drilled to casing point without difficulty. When the drill pipe was pulled up, a mud ring was encountered at 95 ft. One-half barrel of water and 0.1 lb of foaming agent were injected into the air stream which effectively cleaned the hole.

While air drilling at a depth of 2122 ft, an estimated 20 bbl of water entered the well within one minute. This water flow was estimated at 250 bbl per hr and was more than the air available could handle; however, it was found that 90 bbl of water in the form of smooth wet foam could be lifted from 1130 ft with 1200 cu ft per min of air and 16 lb per hr of foaming agent.

Well No. 5, San Juan County, New Mexico

Cleanout of approximately 800 ft of open hole with gas as a circulating fluid was interrupted by formation of mud rings in the casing. Four pounds of foaming agent and 10 bbl of water were injected and a large quantity of distillate, damp shale, and water came out of the exhaust line. The well dried out and began to "dust" within a few minutes and was redrilled without further difficulty. * * *

ALASKA ADDS MUSCLE TO CONSERVATION ACT

In view of the ever-increasing oil activity in our 49th state, the Alaska Oil and Gas Conservation Commission has adopted a new set of rules and regulations which the Commission states "are necessary to the administration of" the oil and gas conservation act of the territory. The rules are of a general nature and are, according to the Commission, of "statewide" application. Effective date for the new legislation is October 1, 1958.

Following are recaps of some of the new regulations. Copies of the complete set of rules are available from the Alaska Oil and Gas Conservation Commission, P. O. Box 1391, Juneau, Alaska.

Drilling

Drilling permit. Before any well is spudded in or drilled in Alaska for oil or gas, application must be made to the Commission and a permit obtained. A fee of $50 must accompany the application.

Bonding. The Commission requires from the operator a bond not less than $5000, conditioned that the well upon abandonment will be plugged in accordance with Commission regulations, or a blanket bond of not less than $10,000 to cover all wells drilling or to be drilled. Operators who have deposited bond with the Federal Government for this purpose are not required to deposit bond with the Commission.

Deviation. The maximum point at which a well penetrates the producing formation "shall not unreasonably vary" from straight hole. Plans for whipstocking may be approved by the Commission except that no permit is required to whipstock short distances to straighten the hole, sidetrack junk, or correct other mechanical difficulties.

Well spacing. The Commission may issue an order setting the spacing units for a pool. However, in the absence of such an order, no well may be drilled for oil on any tract of land other than a governmental quarter section or corresponding governmental lot. The well can not be located closer than 500 ft to any boundry line of the section or lot, nor closer than 1000 ft to the nearest well drilling to or capable of producing from the same pool. No more than one well my be drilled to the same pool on any quarter section or corresponding lot. If the section or lot contains less than 150 acres, special order for drilling one well must be obtained.

If a suitable section or lot embraces two or more separately owned tracts, or if there are separately owned interests in all or part of the unit, drilling can not begin until the tracts or interests have been pooled either voluntarily or in accordance with laws of Alaska.

Abandonment and Plugging

Notice. Before beginning abandonment work on any well, notice of intention to abandon must be filed with the Commission. If a dry hole is to be plugged, approval may be obtained quickly by telephone, telegraph, or radio, but the formal notice must still be filed with the Commission.

Plugging procedure. Unless otherwise approved by the Commission, the procedure for plugging a well calls for filling the hole to, or setting a bridge plug at, the top of each producing formation open to the well bore. In either event a cement plug not less than 50 ft long must be placed immediately above each producing formation open to the hole. In addition, a cement plug of at least 50 ft must be placed within 50 ft below all fresh-water-bearing strata, and a plug must be placed at or near the surface of the ground.

Production Practices

Multiple completion. No well may be multiply produced without approval by the Commission.

Commingling of production. The production from one pool may not be commingled with that from another pool except when the quantities from each source are determined by periodic well tests.

Gas-oil ratios. Any oil well producing with a GOR in excess of 2000 may produce daily only that volume of gas obtained by multiplying its normal unpenalized daily oil allowable by 2000. The daily oil allowable of such a well is determined by dividing its daily gas limit by its producing GOR.

Higher initial gas saturation will produce a . . .

HIGHER RESIDUAL GAS SATURATION

. . . after waterflooding . . . and more oil. This new study shows how residual gas saturation is affected by initial gas saturation, porosity and fluid viscosity . . . and correlates results with previous studies

Stephen G. Dardaganian
Atlantic Refining Company
Lafayette, Louisiana

HIGHER initial gas saturation, up to a point, results in a higher residual gas saturation . . . and a higher percentage of oil recovery. A higher residual gas saturation is desired because the additional gas occupies pore volume that would otherwise be occupied by non-recoverable oil. Laboratory investigation shows an almost proportional increase in residual gas saturation for a corresponding increase in initial gas saturation, when the initial gas saturation is not above 10 percent. Above this percent of initial gas saturation, final gas saturation increases but not proportionally.

At 10 percent initial saturations, the core samples tested showed residual saturations ranging from 8 to 10 percent. For initial saturations of 40 percent, residual saturations ranged from 14 to 30 percent. These results are shown in Fig. 1.

When initial gas saturation is above 14 percent, an increase in porosity will cause a decrease in residual gas saturation. Fig. 3 illustrates this characteristic.

The ratio of viscosity of displacing phase to the displaced gas was used as a characterizing parameter of the fluid system. It was found as this ratio increased, lower residual gas saturation occurred. The curves in Fig. 4 show this characteristic.

This article was presented as a paper entitled "A Study of the Establishment of the Residual Gas Saturation During a Water Flood" at the Joint Technical Meeting of the University of Texas—Texas A&M student AIME Chapter held February 27 and 28, 1958.

Additional Study Needed

Advancement in the field of reservoir engineering today has made it a common practice to initiate pressure maintenance programs where solution gas drive reservoirs or combination solution gas and water drive reservoirs are involved. As a result of pressure maintenance, more efficient displacement and higher recoveries are realized in most cases. Years ago, however, the idea of pressure maintenance had not yet been fully investigated and developed. Consequently, most of the solution gas drive reservoirs were allowed to produce by pressure depletion.

Because of the inefficiency of this method of production, a large number of such reservoirs are in existence today at some pressure substantially below their original bubble point pressure. Many of these reservoirs still contain a considerable amount of recoverable oil. Waterflooding is utilized to a great extent in the recovery of this oil. There-

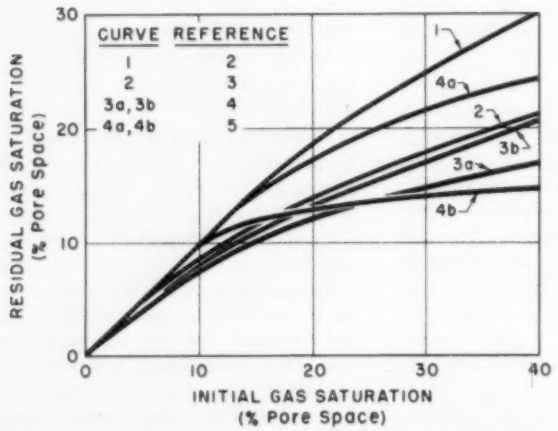


FIG. 1. **Effect of initial gas saturation** on residual gas saturation of cores in previous studies.

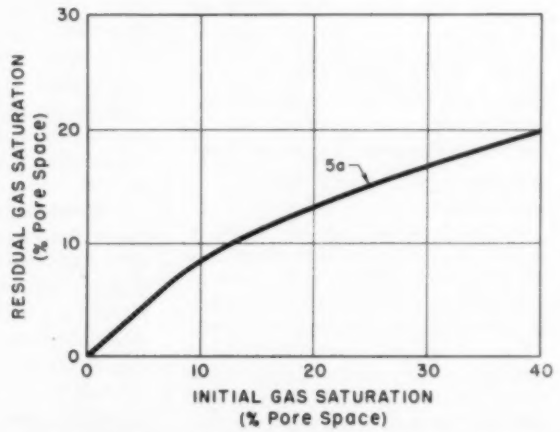


FIG. 2. **Effect of initial gas saturation** on residual gas saturation of core "A."

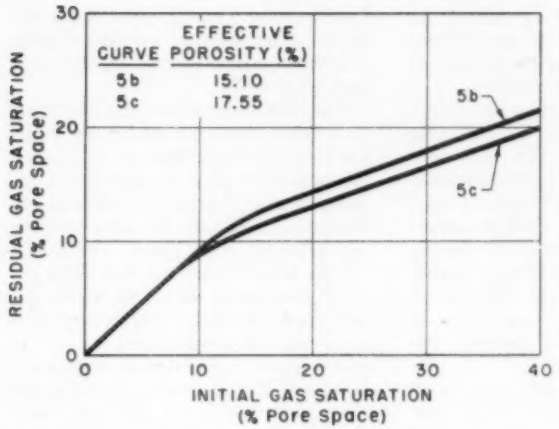


FIG. 3. **Effect of initial gas saturation** on residual gas saturation of core "B."

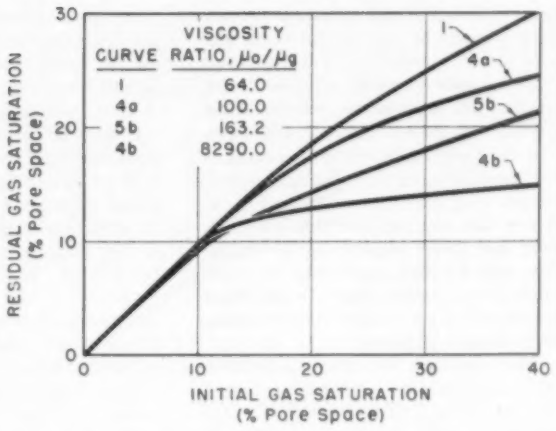


FIG. 4. **Relation between residual and initial gas saturation** for systems of varying viscosity ratio.

fore, the mechanism of fluid flow in a multi-phase system is one which needs considerable study.

Several recent investigations have illustrated the effect of the presence of free gas on oil recovery by waterflooding. It has become apparent that the presence of free gas increases the oil recovery. The residual gas saturation after a water flood is believed to be one of the factors contributing to the increased oil recovery. The residual (trapped) gas occupies pore space that would have otherwise been occupied by the residual oil.

While conducting these studies many of the investigators arrived at a relationship between the initial and residual gas saturations. However, there was not sufficient information regarding this relationship. Therefore, this study was conducted investigating the establishment of the residual gas saturation during a water flood.

Previous Investigations

Geffen and others[1] concluded from their studies that a substantial amount of gas would remain in the pore space of water invaded media originally containing a free gas saturation. It was estimated that the range of the trapped gas saturation would be 15 to 50 percent pore space and not the "critical gas saturation" usually taken as 1 to 11 percent pore space.

Holmgren and Morse[2] were among the first to express a relationship between the initial free gas saturation and the trapped gas saturation. They arrived at this relationship while studying the effect of free gas saturation on oil recovery by waterflooding. A Nellie Bly sandstone core 5-in. in diameter and 5 ft long was used in this study. It had an average porosity of 27.4 percent and an average specific permeability of 612 md. The core was initially saturated 100 percent with brine. The brine saturation was reduced to a value in the range of 26.4 to 30 percent pore space by flooding with live oil.

A gas drive was conducted at a constant pressure until the gas saturation was increased to a sufficiently high value that subsequent oil flooding would obtain the desired residual gas saturation. The approximate viscosity range of the oil was from .75 to .85 cps. The saturations were determined by volumetric material balance in the liquid system. The trapped gas saturation is expressed as a function of the initial gas saturation by Curve 1, Fig. 1.

The purpose of the study conducted by Dyes[3] was to illustrate that the production of a water-driven reservoir at pressures below the bubble point would improve the oil displacement efficiency as a result of gas evolution. Small cores taken from the Wilcox sand reservoir were used in this study. The average porosity was 21 percent and brine permeability was 300 md. An irreducible water saturation of 20 percent pore space in the presence of oil was established by restored state technique. The viscosity of the oil ranged from .74 to 1.51 cps.

An initial gas saturation was established by gas injection. The oil and gas saturations were reduced to residual by a water flood. The value of the residual gas saturation was determined by material balance. The relation between the initial and residual gas saturations is shown by Curve 2, Fig. 1.

Kruger[4] investigated the relation between residual gas saturations after water floods and the initial gas saturations and saturation history. The data presented in his work represented floods conducted on two cores: Core A and Core B. Core A, taken from a block of West Texas building stone, was a fine grained, well consolidated sandstone 12-in. long and 1.625-in. in diameter. It had a permeability of 270 md and a porosity of 28.4 percent. Core B, taken from a Woodbine outcrop, was a coarse grained, loosely consolidated sandstone 12-in. long and 2.125-in. in diameter. It had a permeability of 3720 md and a porosity of 34.7 percent.

The cores were saturated 100 percent with distilled water. A mixed stream of distilled water and air was injected into the cores to establish the initial saturation conditions. The residual saturations were obtained by waterflooding. Saturation measurements were made by gravimetric methods. Curves 3a and 3b, Fig. 1, represent the relation obtained between the residual and initial gas saturations. **From these experiments it is apparent that residual gas saturation is increased when the initial gas saturation is increased.**

Experimental studies covering a wide range of core materials and fluid properties were conducted by Kyte and others.[5] They investigated the mechanism of oil displacement by water in a partially gas-saturated porous medium. The core material was Torpedo sandstone which was 1.95 in. in diameter and 8.5 to 10.0 in. in length. Two Torpedo sandstone cores were used. One had a porosity of 22.8 percent and an air permeability of 375 md. The other core had a porosity of 24.9 percent and an air permeability of 640 md. Connate water saturations ranging from 21.9 to 26 percent pore space were established prior to waterflooding.

Initial gas saturations were established by driving the cores with gas (helium). Residual gas saturations were obtained two ways: Water-flooding and oil-flooding. The viscosities of the oils used with the Torpedo cores were 1.4 and 116 cps. The relationship

between residual and initial gas saturations was found to depend upon the core material and type of oil used.

The higher viscosity oil gave lower residual gas saturations, and the lower viscosity oil gave a higher residual gas. The relationship between the residual and the initial gas saturations are represented by Curves 4a and 4b, Fig. 1. **It was also concluded in this investigation that under similar initial saturation and flooding conditions the residual gas saturation after a water flood would be less for an oil-wet system than for a water-wet system.**

The core materials that were used in the investigations presented in Fig. 1 were water wet. It was found that the average system pressure had little effect on the results. Therefore, both high-pressure and low-pressure systems yielded comparable results. Although there was considerable information available regarding the establishment of residual gas saturations during water-flooding, there was found to be a need for additional and more detailed study. The following are the procedures and results of this investigation.

Experimental Procedure

This investigation was conducted using three phase low-pressure flow systems in which oil displaced free gas in the presence of immobile water. Only the desaturation process was investigated as it was felt that it more nearly approached the saturation history of the reservoir. This process involved the creation of the desired free gas phase by displacing the oil from the core, containing immobile water, by a mixed stream of oil and gas until steady state flow conditions were approximated.

The cores were then flooded with oil and the residual gas saturation determined. This gave a relationship between the initial free gas saturation and the trapped gas saturation that existed within the oil bank. The saturations were determined by volumetric balance and verified by gravimetric means. Table 1 gives a physical description of the experimental systems.

Two Torpedo sandstone cores, Cores "A" and "B," mounted in lucite jackets were used in this study. The cores were 4.76 cm in diameter and approximately 86 cm in length. Core "A" had a porosity of 22.4 percent and a brine permeability of 330 md. Core "B" had a porosity of 23.8 percent and a brine permeability of 518 md. The cores were of sufficient length to allow a liquid bank to form and to reduce the influence of the "end effects."

The fluids used in this work were water, kerosine, and air. The water contained a salt concentration of 40,000 ppm. The viscosities of the brine and kerosine were 1.25 cps and 3.10 cps, respectively, at 60 F and 14.65 psia. The water was aerated prior to injection into the core so as to reduce the tendency of the air within the core going into solution while conducting the tests. The air, upon entering the flow system, was saturated with water by bubbling through a water reservoir to reduce the tendency of the air to evaporate the connate water within the core. All of the fluids prior to entering the core were filtered through alundum discs mounted in lucite to prevent the possibility of any plugging action within the cores.

The cores were cleaned, dried with dry air, and then weighed. After evacuating the cores, they were saturated with a measured volume of water and the porosities determined. Oil was injected into the cores to reduce the water to some residual saturation which would be immobile during the tests. The water saturation in Core "A" was reduced to 34.1 percent pore space and in Core "B" to 36.5 percent pore space. The connate water in Core "B" was further reduced by evaporation to 26.3 percent pore space, and additional tests were conducted. The influence of effective porosity on the residual gas saturation after flooding was investigated by changing the connate water saturation in Core "B."

The saturations within the core prior to flooding were established by a desaturation process. With the oil saturation within the cores at some maximum value, a mixed stream of oil and gas was used to reduce the oil saturation and establish a gas phase. The mixed stream was allowed to flow into the cores until steady state flow within the cores was attained. Upon establishing steady state flow conditions, the saturations existing within the cores were determined. Having established the desired initial conditions, the cores were flooded with oil. The residual saturations were determined.

Since several such tests were to be run for various initial saturations, a low gas saturation was established prior to the flood in the first tests. The initial gas phase was increased with each successive run. This made it possible to establish the desired initial saturation conditions by recharging the cores immediately after the completion of each flood. An upstream pressure of 50 psig with a differential pressure across the core of approximately 10 psi was maintained during the process of both charging and flooding the cores. The tests were conducted in such a manner that the free gas saturation present in the oil bank was not dissolved under the pressure gradients employed.

The residual saturations were established by flooding the charged cores with oil. The assumption was made that the residual gas saturation after an oil flood and after a water flood would be the same. This was experimentally illustrated by Kyte and others.[5] They found that while conducting a water flood in the presence of free gas the trapped gas saturation in the water bank corresponded to the trapped gas saturation in the oil bank developed ahead of the waterflood

TABLE 1. Description of Experimental Systems.

Reference number	Curve	Core material	Porosity percent	Permeability md	Viscosity		Connate water saturations
					Oil cps	Gas cps	percent pore space
2	1	Nellie Bly sandstone	27.4	612	.75— .85	.0125	26.4—30
3	2	Wilcox sand	21.0	300	.70—1.51	.015	20
4	3a	West Texas building stone	28.4	270	1.0*	.019	Unknown
4	3b	Woodbine sand	34.7	3720	1.0*	.019	Unknown
5	4a	Torpedo sand	22.8	375	1.4	.014	21.9—26
5	4a	Torpedo sand	24.9	640	1.4	.014	21.9—26
5	4b	Torpedo sand	22.8	375	116.0	.014	21.9—26
5	4b	Torpedo sand	24.9	640	116.0	.014	21.9—26
6	5a	Torpedo sand	22.4	330	3.1	.019	34.1
6	5b	Torpedo sand	23.8	518	3.1	.019	36.5
6	5c	Torpedo sand	23.8	518	3.1	.019	26.3

*Distilled water

Note: All systems were water wet.
Saturations were determined by material balance.

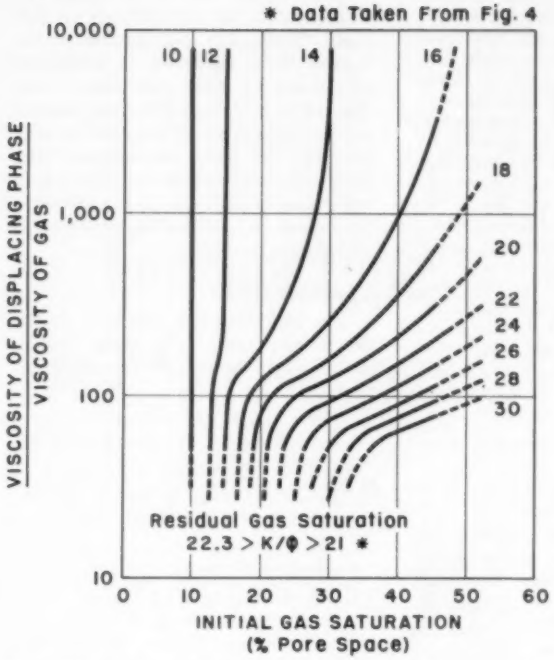


FIG. 5. **Effect of viscosity ratio** (u_o/u_g) on residual gas saturation.

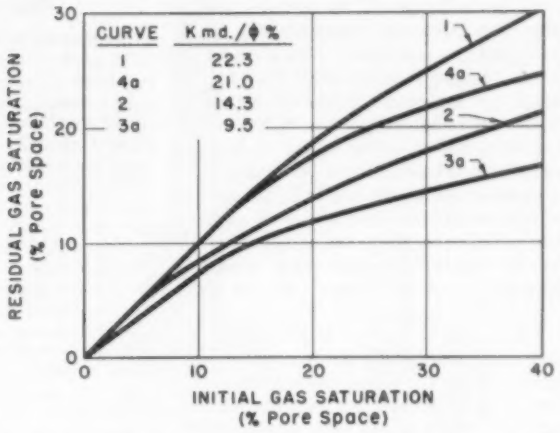


FIG. 6. **Relation between residual and initial gas saturation** for systems of varying rock parameter (K/φ).

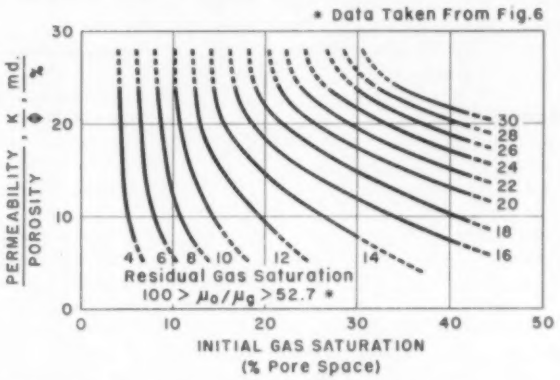


FIG. 7. **Effect of rock parameter** (K/φ) on residual gas saturation.

front. Establishing the residual saturations by oil flooding facilitated these studies and gave a more representattive relationship between the initial saturation conditions and the residual gas saturations after a water flood.

Interpretation of Results

The relationships between the initial and residual gas saturations obtained from tests using Core "A" and Core "B" are illustrated in Fig. 2 and 3, respectively. More detailed information may be found in the study conducted by Dardaganian.[6]

The residual gas saturations in Cores "A" and "B" were investigated for initial gas saturations ranging from 0 to 30 percent pore space. Although attempts were made, high initial gas saturations could not be established by the method used in this study. The relative permeability to oil became very small at about 35 percent oil saturation because of the presence of a connate water saturation of approximately 35 percent pore space.

The results obtained from both cores were in good agreement. The residual gas saturations in both cores increased as the initial gas saturations increased with the increase becoming proportionally smaller for higher values of initial gas saturation. It can be seen in Fig. 2 and 3 that very little gas was displaced by the oil flood for lower initial gas saturations. The increase in the residual with the initial gas saturation was linear for initial gas saturations ranging from 0 to about 9 percent pore space. The proportional increase of the residual with increasing initial gas saturations decreased as the initial gas saturations increased above 9 to 10 percent pore space.

The influence of the effective pore space upon the behavior of the residual gas saturation within and behind an oil bank is illustrated by Curves 5b and 5c in Fig. 3. Using Core "B," floods were conducted in the presence of immobile water saturations of 36.5 and 26.3 percent pore space. The residual gas saturations decreased with an increase in the effective pore space. For initial gas saturations from 0 to 9 percent, changing the effective porosity did not have a measurable effect on the residual gas saturations. For initial gas saturations greater than 13 to 14 percent pore space, the residual gas saturation decreased by 1 to 1.5 percent pore space as a result of an increase in the effective porosity of 2.45 percent pore space.

Correlation of Results With Previous Studies

The results of this and previous studies were correlated. Comparison of these studies yielded information concerning the apparent effect of the following upon the residual gas saturation after a water flood: Initial gas saturation, fluid properties, and rock characteristics. To study the effect of each of these features, it was necessary to select curves from studies in which these features substantially differed. The curves to be compared were also selected in such a manner that the features not being considered were relatively similar.

The effect of the initial gas saturation upon the residual gas saturation was reflected in each of the curves in Fig. 1, 2 and 3. The general features of these curves were similar. There was very little difference between the initial and residual gas saturations for lower

initial gas saturations. The residual gas saturation increased proportionally as the initial gas saturation. This proportional increase became smaller as the initial gas saturation increased above about 9 percent pore space. Sufficient data was not available to arrive at a suitable correlation for the residual gas saturations corresponding to initial gas saturations greater than about 40 percent pore space. However, it appeared that the residual gas saturations would approach some maximum value as a limit for higher initial gas saturations.

The variation in residual gas saturations indicated by the different curves increased as the initial gas saturation increased. This was attributed to the fact that the residual gas saturation varied with the fluid and rock properties which had a greater influence at higher initial gas saturations. There was sufficient variation in these properties to make a general study of their effects possible.

Nomenclature

K – total effective permeability, md.
ϕ – fractional porosity.
μ – fluid viscosity, cps.

Subscripts

g – Gas
o – Oil

The ratio of the viscosity of the displacing phase to the displaced gas (μ_o/μ_g.) was used as a characterizing parameter for the fluid system. The effect of this parameter upon the residual gas saturation is illustrated by the curves in Fig. 4. The residual gas saturation was plotted as a function of the initial gas saturation for systems having different viscosity ratios. The values of the parameter (k/ϕ) characterizing the rock ranged from 21 to 22.3. These curves indicated that increasing values of the viscosity ratio gave lower values of residual gas saturation. The residual gas approached a minimum saturation value as a limit at high viscosity ratios.

An attempt was made to arrive at a representative plot for interpolation purposes. This plot is shown in Fig. 5 in which the residual gas saturation is plotted as a function of the initial gas saturation and the viscosity ratio between the displacing phase and the gas. The data represented in this plot were taken from the curves presented in Fig. 4. The viscosity ratio had little effect upon the residual gas saturation for low values of initial gas saturation. The viscosity ratio had an increasing effect upon the residual gas at higher values of initial gas leaving higher values of residual gas at low viscosity ratios and lower residuals for higher viscosity ratios. Variations in the viscosity ratio had the greatest effect on the residual gas saturations for ratio values ranging from about 40 to 200.

The ratio between the permeability and porosity (K/ϕ) was used as a rock characterization parameter. The effect of this parameter upon the residual gas saturation is shown by Fig. 6. The relation between the initial and residual gas saturations are expressed for systems having different values of the rock parameter. The values for viscosity ratio between the displacing fluid and gas of the fluid systems represented in this figure ranged from 52.7 to 100. The curves in this figure indicated that the residual gas increased as this rock parameter increased. The residual gas appeared to be greater for the more favorable pore size distributions assuming that an increase in this rock parameter reflected an improvement in the pore size distribution.

The residual gas saturation was plotted as a function of the initial gas saturation and the rock characterization parameter (K/ϕ) in Fig. 7. The uniform pattern in this figure indicated that this rock parameter might be favorable for correlation purposes. The data for this plot were taken from the curves in Fig. 6. The rock parameter had little effect upon the residual gas at low values of initial gas and high values of the parameter. Lower values of the rock parameter gave lower residual gas saturations and higher values of this parameter gave higher values for residual gas. For the range of viscosity ratios investigated, the rock parameter had little effect upon the residual gas for rock parameter values greater than 26.

Sufficient information was not available to make a study of the influence of effective porosity upon residual gas saturation. However, Curves 5b and 5c in Fig. 3 did illustrate this effect for a slight change in effective porosity. An increase in the effective porosity reduced the residual gas saturation.

There were two rock properties which were not considered in this study: Wettability and pore size distribution. Some reference to wettability was made by Kyte and others[5] who showed in their studies that the residual gas saturations for oil wet systems were less than for water wet systems. The pore size distribution was reflected to an extent in the rock characterization parameter (K/ϕ) used in this study for correlation purposes.

Conclusions

The following is a summary of the conclusions resulting from this investigation and previous similar investigations.

1. The residual gas saturation after a water flood is a function of the free gas saturation prior to the flood.
2. The residual gas saturation is influenced by the fluid properties.
3. The residual gas saturation is also a function of the physical characteristics of the rock.
4. It may be possible to derive a useful relationship between the residual gas saturation after a water flood and the physical properties of the reservoir rock and fluids.
5. A curve may be drawn similar to Curve 5a in Fig. 2 which may be useful as a first approximation if only the free gas saturation existing within the reservoir is known.

Sufficient information is not available to present exact correlations. Further detailed investigation would be of considerable aid in more accurately characterizing the gas phase behavior during a water flood.

Acknowledgments

The author wishes to express appreciation for the supervision and guidance extended by D. M. Bass and J. W. Amyx and for the helpful advice of A. B. Dyes.

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The Author

Stephen G. Dardaganian *received a BS degree in geological engineering from Texas A&M in 1951. He was commissioned in the United States Air Force and sent to Florida State University to study meteorology. He served as meteorologist for four years before separating from active duty at which time he returned to Texas A&M where he received a MS degree in petroleum engineering in 1957. While studying for his MS degree, he was employed by the Texas Petroleum Research Committee as a Junior Technologist. He was invited to become an associate member of the Society of Sigma Xi as a result of the research conducted for his thesis. He recently completed the engineer training program with The Atlantic Refining Company and is presently employed as a Junior Engineer in Lafayette, Louisiana.*

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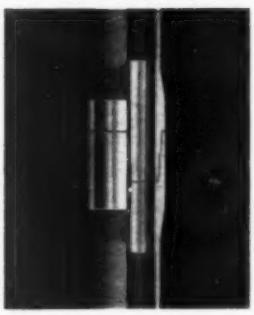

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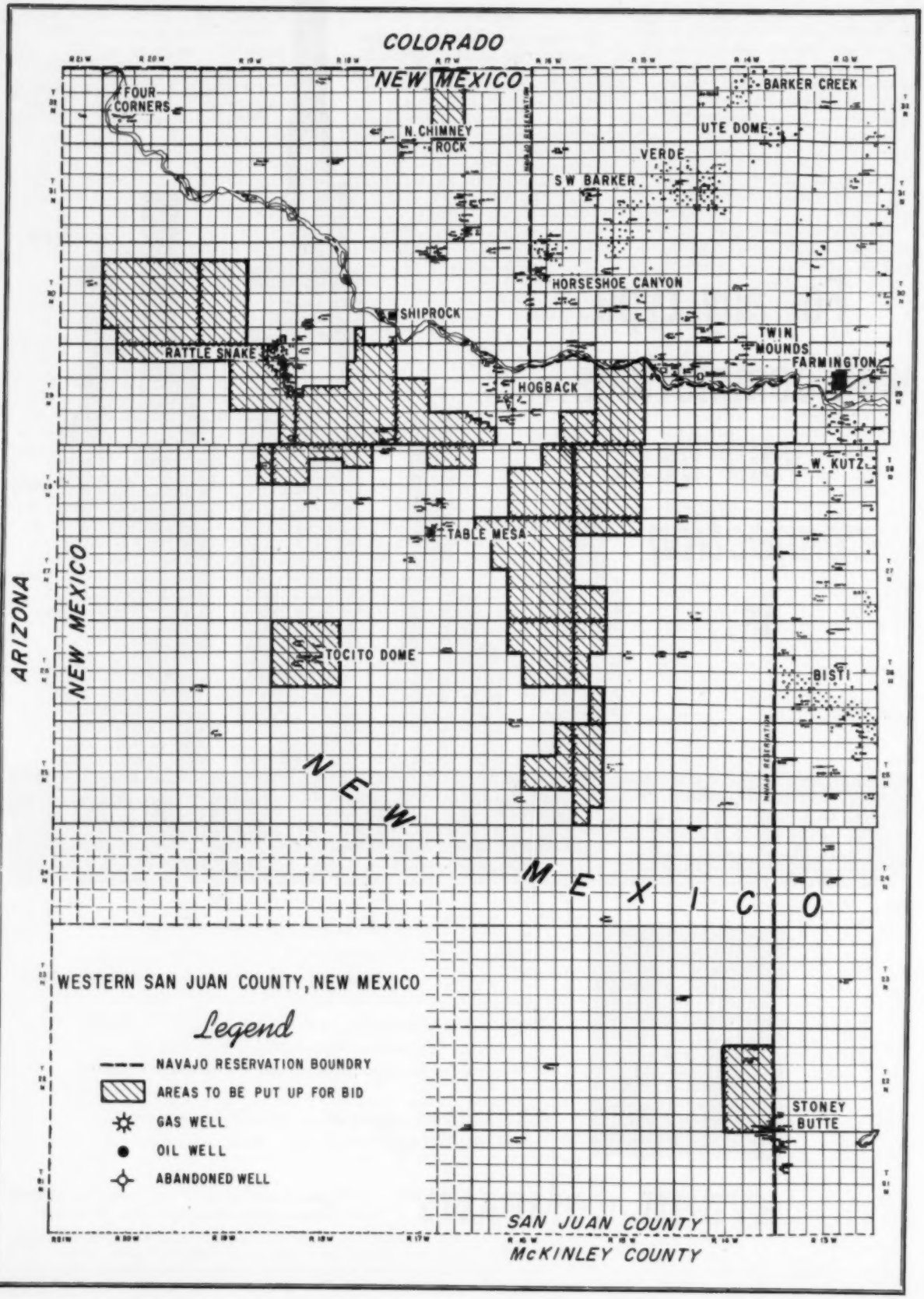
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←— Lease-buying operators will have multiple-pay possibilities in mind at the Navajo lease sales in December and January. Every dot on the map indicates an existing well — and there are a lot of wide-open spaces yet undrilled. In Rattlesnake field, near one of the largest blocks up for lease, production has been found at less than 700 ft.

200,000-Acre Navajo Lease Sale

Oil company requests prompt bonus bid offerings in San Juan County, New Mexico

John K. Petty
Consulting Geologist
Farmington, New Mexico

PAUL JONES, chairman of the Navajo Tribal Council, has announced that the Navajo Tribe, in conjunction with the Navajo Agency of Indian Affairs, will advertise certain tribal lands in San Juan County, New Mexico, for oil and gas leasing.

This land, approximately 200,000 acres, will be offered in sales in December 1958 and January 1959.

The proposed sales are based on requests made by oil companies and individuals for particular tracts of acreage to the Navajo Tribal Council at Window Rock, Arizona. The specific tracts to be offered for competitive bonus bids are to be listed in the formal announcement made by the Council. Mailing list inquiries may be made to the Council at Window Rock.

High Bidding?

The shaded areas on the accompanying map will be offered in the lease sales. It will be recalled that on the same type series of sales one year ago, the highest successful bonus bid was $4308 per acre in the Aneth-Ratherford area—the hottest spot in the Four Corners.

How high the bidding in December and January will go, only time will tell. The area is serviced with pipelines now buying oil and gas. All the acreage is readily accessible for moving drilling equipment in. This was hardly the situation a year ago.

None of the offered acreage will be over 50 miles west of Farmington, New Mexico. The Stoney Butte area offering is about 40 miles south of Farmington.

Existing Production

As shown on the accompanying map, much of this offered area is adjacent to the Rattlesnake oil field from which about 5,000,000 bbl of high gravity oil have been produced at 680-90 ft from the Dakota sandstone. This is a very prolific and popular producing horizon in northern New Mexico at present. The Pennsylvanian produces in this field at a depth of 6585-775 ft. The field is on an anticline.

The Four Corners (Hunav) field, 8 miles north of the northwestern-most acreage being offered, produces oil and gas from the Paradox at 4672 ft. The Bita Peak gas field four miles west of the Four Corners field produces from the Paradox at 5080-102 ft.

The Hogback Feature, an eastward steep-dipping monocline, extends in a northeast-southwest direction just south of the Barker Creek, Ute Dome, Verde Gallup, Southwest Barker and Horseshoe Canyon fields. Then it extends southwestward along the east side of the Hogback field. This field produces from the Dakota at 633-795 ft, the Pennsylvanian at 6166-632 ft, and until recently, from the Mississippian at 6930-7030 ft. The Hogback feature then extends southeastward and past the south side of the Table Mesa field. The Table Mesa produces oil from the Dakota at a depth of 1315-426 ft and is on an anticlinal dome. It has produced over 1,000,000 bbl of oil.

The Hogback then continues its southwestern trend passing the south edge of the Stoney Butte field, producing from the Dakota at the 3645-50 ft interval; it is situated on an anticline.

Multiple Possibilities

West of the Hogback feature is the Paradox Basin and east of it is the San Juan Basin. The main interest in the acreage west of the Hogback is for Dakota pay—as well as for Pennsylvanian, Mississippian, and possibly Devonian production.

The acreage to the east of the eastward dipping monocline and lying in the San Juan Basin have all the formation possibilities of the western acreage plus the chance for Gallup oil.

The very lucrative Bisti field, producing from the Gallup at 4560-973 ft, is only 10 miles southeast and east of the acreage tracts to be offered in the December and January sales.

The Four Corners area has been favored by completion and connection of oil and gas lines, and good possibilities for a processing plant for gas, all owned by major companies who intend to produce more and more oil from their leases in coming months. This confidence in the area is noted daily by the many persons arriving in the area to make their homes. ★ ★

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PRODUCTION APPLICATIONS

SINGLE ZONE Normal Completion

SINGLE ZONE Permanent Type Well Completions

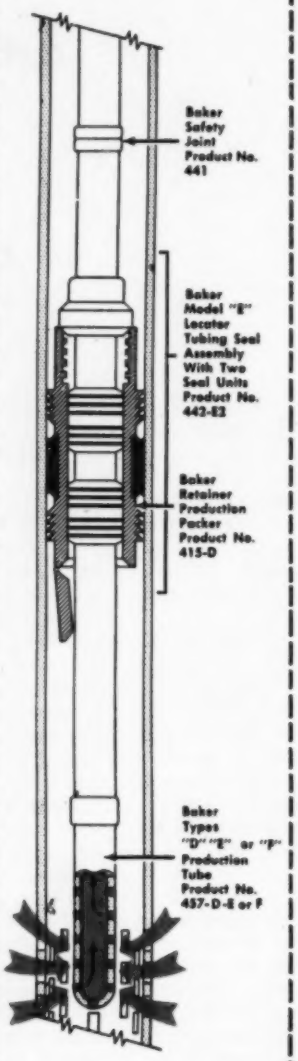
Baker Retainer Production Packer Product No. 415-D

FEATURES

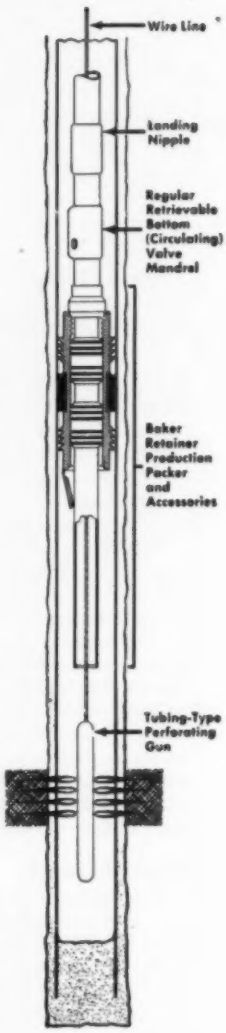
Holds any pressure from either above or below that is safe for the casing, even under temperatures in excess of 300°F.

Pack-off is independent of set-down weight or tension. Tubing string is free; just pick up (or unlatch and pick up) to remove it.

Use it as a squeeze and testing tool or as a temporary or permanent bridge plug in conjunction with any production application.

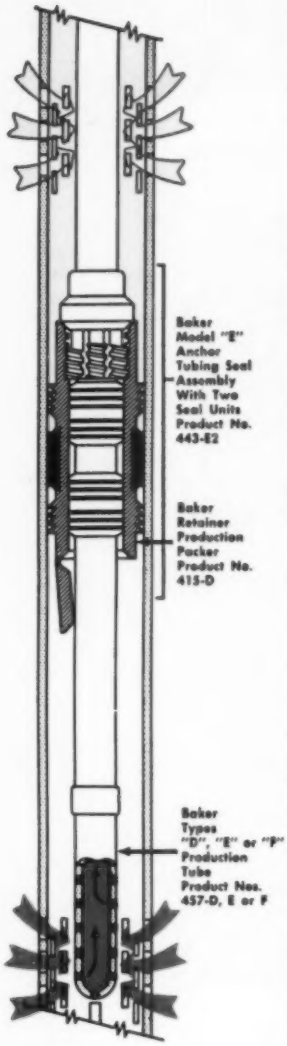

Baker Safety Joint Product No. 441
Baker Model "E" Locator Tubing Seal Assembly With Two Seal Units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D" "E" or "F" Production Tube Product No. 457-D-E or F

Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.



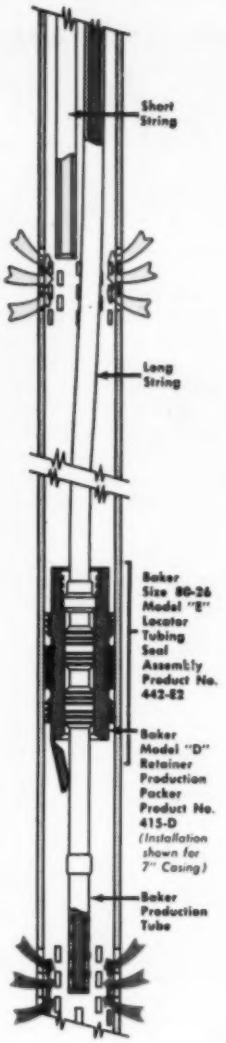
Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the Packer.

DUAL ZONE
Normal Completion


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D", "E" or "F" Production Tube Product Nos. 457-D, E or F

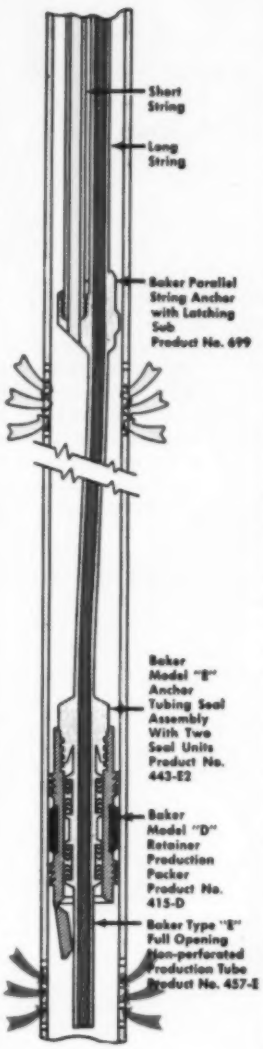
Illustrates Packer set in casing, with anchored production string for dual-zone production. Tubing can be released from Packer by rotating to right.

DUAL ZONE
Parallel String
Short String Hanging Free


Short String
Long String
Baker Size 80-26 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Model "D" Retainer Production Packer Product No. 415-D (Installation shown for 7" Casing)
Baker Production Tube

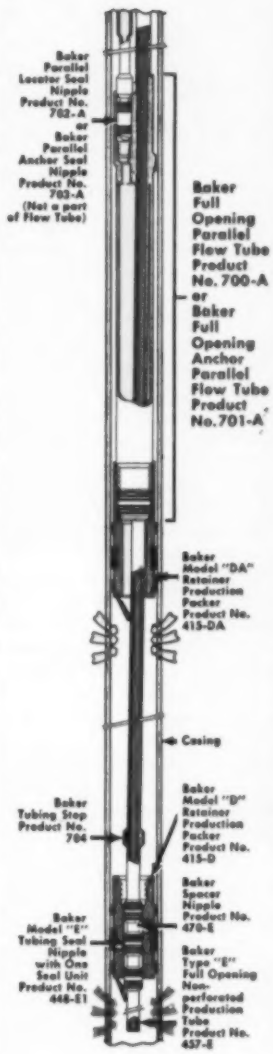
Permits removal of either string independently of the other regardless of sequence. Full-Opening (Tubing I.D.) Long String to lower zone.

DUAL ZONE
Parallel String
Short String Anchored


Short String
Long String
Baker Parallel String Anchor with Latching Sub Product No. 699
Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Permits removal of either string independently of the other, however long string must be run first. Short string pulled first. Full-Opening (Tubing I.D.) Long String.

DUAL ZONE
Parallel String Two-Packer Hook-up


Baker Parallel Locator Seal Nipple Product No. 702-A or
Baker Parallel Anchor Seal Nipple Product No. 703-A (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700-A or Baker Full Opening Anchor Parallel Flow Tube Product No. 701-A
Baker Model "DA" Retainer Production Packer Product No. 415-DA
Casing
Baker Tubing Stop Product No. 704
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Spacer Nipple Product No. 470-E
Baker Model "E" Tubing Seal Nipple with One Seal Unit Product No. 448-E1
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Illustrates Two-Packer parallel string installation with each zone confined to its individual tubing string with full-opening to lower zone for use of all permanent-type completion tools.

Increased accuracy for quantitative analysis of electric logs knowing . . .

Electrical Resistivity of Oil Field Brines

IN MISSISSIPPI AND ALABAMA

Murphy E. Hawkins and Owen W. Jones
Petroleum Engineers
U. S. Bureau of Mines
Dallas, Texas

DEVELOPMENTS in instruments, field techniques, and interpretative processes during the past few years have brought about general acceptance of quantitative interpretation of electric logs by the petroleum industry. Technicians can now, with reliable resistivity data, interpret electric logs much more accurately and extensively than was thought possible a few years ago, when logs were used primarily to correlate formations and as tools to indicate whether or not formations contained hydrocarbons.

Technical advances in interpretation have been much more rapid than the accumulation of field data necessary to utilize them fully. Field data essential for the quantitative analysis of an electric log include knowledge of the electrical resistivity of the formation waters.

When water-resistivity data are not available it is necessary to estimate these values from electric logs or to assume values based on experience. Therefore, the information presented here should result in increased accuracy of log interpretation of wells drilled in the area of Mississippi and Alabama included in this report (see Fig. 1).

Formation-water resistivity is useful also in many instances for determining casing leaks and as an aid in correlating geologic formations. However, unless large variations in the resistivity of different formation waters exist, its use for these purposes is limited.

Requests for previous reports on water resistivity[1,2,3] have shown a need for this information by the petroleum industry. Therefore, water resistivity data have been compiled from 24 oil-productive counties in Mississippi and Alabama.

Average water-resistivity data presented here represent measured and calculated values of produced brines from approximately 1000 wells in 116 fields in Mississippi and Alabama. The location of oil fields from which water samples were obtained are shown on index maps, Fig. 5 through 8. Average water resistivity, tabulated by counties, fields, and productive formation, is shown in Tables 1 through 4. These tables also give the subformation producing intervals (if known) and the average depth or range in depths of the formations. A generalized geological column of subsurface formations in Mississippi and Alabama, adapted from the Mississippi Geological Society,[4] is shown as Fig. 2.

A study of the data presented here indicates that lateral variations in the resistivity of formation water are

FIG. 1. Twenty-four oil productive counties in Mississippi and Alabama are included in this report on water resistivities from some 1000 wells in 116 fields in this region.

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usually small within local areas. Therefore, reasonably reliable resistivity of formation waters in fields and wildcat areas not included in the report can be interpolated from the data presented. However, care in interpolating should be exercised where subsurface conditions, such as extreme faulting, may radically alter the geology of the area under study.

Definition of Water Resistivity

Electrical resistivity of water is the resistance of a unit volume of water. The term used in electric logging to express water resistivity is the ohm-meter²/meter (ohm-m²/m). This unit expresses the resistance, in ohms, of one cubic meter of water to the flow of a uniform electric current parallel to one side of the cube. Water resistivity in this report will be expressed simply as ohm-meters (ohm-m).

In electrolytic conductors, such as formation waters, the resistivity decreases with increase in temperature, as shown by the curves in Fig. 3. All water resistivities in this report have been adjusted to 75 F for correlative purposes. Before these values are used in electric log interpretations, they must be adjusted to the appropriate formation temperature by using the curves in Fig. 3.

SYS.	SERIES	GROUP	FORMATION	TYPICAL NAMES OF PRODUCING SUBFORMATIONS
TERTIARY	EOCENE	CLAIBORNE	COCKFIELD	
			COOK MOUNTAIN	
			SPARTA	
			ZILPHA	
			WINONA	
			TALLAHATTA	
		WILCOX	WILCOX (UNDIFFERENTIATED)	STEWART, BLAKE, ARTMAN, PEARLINE, MCKITTRICK, ARMSTRONG, BENBROOK, BAKER, WILSON, PARKER, OGDEN, BARNSDALE, WALKER, MINTER, AND KEE SANDSTONES
		MIDWAY	PORTERS CREEK	
			CLAYTON	
UPPER CRETACEOUS	GULF	NAVARRO	SELMA	JACKSON GAS ROCK, SELMA GAS ROCK, WOODRUFF SANDSTONE, ANDERSON SANDSTONE
		TAYLOR		
		AUSTIN	AUSTIN (UNDIFFERENTIATED)	
			EUTAW / AUSTIN CHALK	PERRY-WILBURN, STEVENS, LAMMONS, TRAVIS, AND HATTEN SANDSTONES
		EAGLE FORD	EAGLE FORD (LOWER EUTAW)	MCGRAW, CITY BANK, STANLEY, LEWIS, CHRISTMAS MORRISON, AND BRUMFIELD SANDSTONES
		TUSCALOOSA	UPPER TUSCALOOSA	GHOLAR SANDSTONE, POWELL SANDSTONE
			MARINE TUSCALOOSA	MCDONALD SANDSTONE
			LOWER TUSCALOOSA	EVANS, PILOT, MULLENS, MASSIVE, AND STEVENS SANDSTONES
LOWER CRETACEOUS	COMANCHE	WASHITA & FREDERICKSBURG UNDIFFERENTIATED	UNDIFFERENTIATED / DANTZLER MEMBER	NELSON SANDSTONE
			UNDIFFERENTIATED / LIMESTONE UNIT MEMBER	
		TRINITY	PALUXY (UPPER GLEN ROSE)	
			MOORINGSPORT (UPPER GLEN ROSE)	
			FERRY LAKE ANHYDRITE (UPPER GLEN ROSE)	
			RODESSA (LOWER GLEN ROSE)	
	COAHUILA		SLIGO (LOWER GLEN ROSE)	BAILEY SANDSTONE
			HOSSTON	
JURASSIC			COTTON VALLEY	
			BUCKNER	
			SMACKOVER	

FIG. 2. **Generalized geological column** in South Mississippi and Southwestern Alabama.

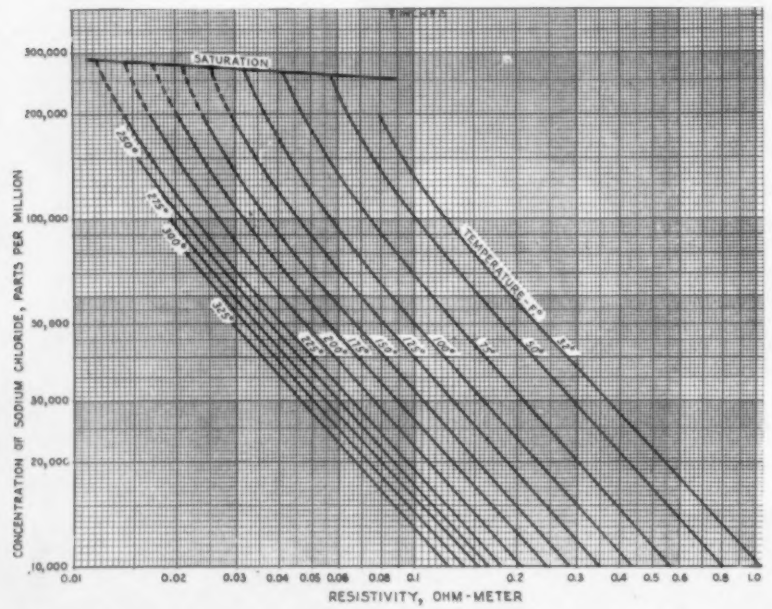


FIG. 3. **Relation of resistivity to temperature** and concentration of sodium chloride solutions.

In this report will be expressed simply as ohm-meters (ohm-m).

In electrolytic conductors, such as formation waters, the resistivity decreases with increase in temperature, as shown by the curves in Fig. 3. All water resistivities in this report have been adjusted to 75 F for correlative purposes. Before these values are used in electric log interpretations, they must be adjusted to the appropriate formation temperature by using the curves in Fig. 3.

Methods of Determining Water Resistivity

Direct measurement of water resistivity. The simplest and most accurate method of finding the resistivity of water is by direct measurement of samples with a resistivity meter. All samples collected for this study were measured with a resistivity meter (Schlumberger electronic portable mud tester, type EMT-A), and the resistivities obtained were adjusted to a temperature of 75 F by using the curves in Fig. 3.

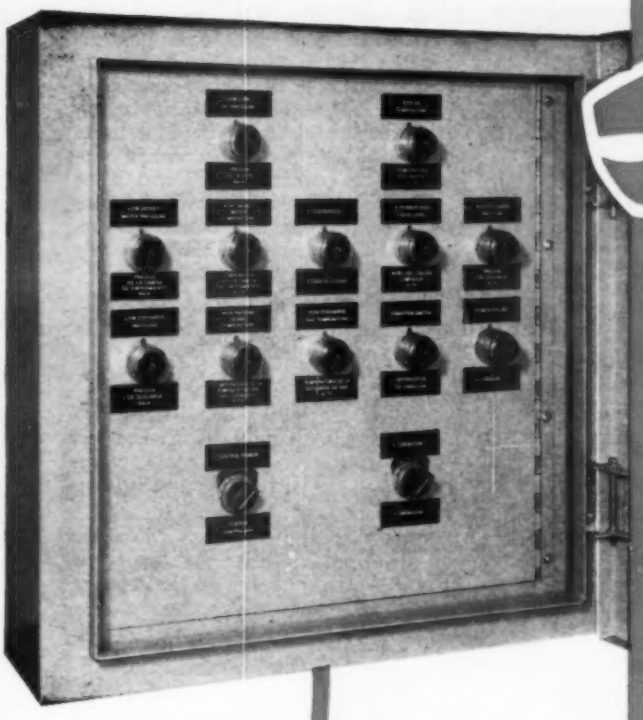
Calculating resistivity from mineral analyses of water. Several methods have been published for calculating the resistivity of waters from their mineral analyses. A method developed by Dunlap and Hawthorne[5] was used in making the calculated resistivities included in this report. In this method multipliers are used to convert the concentration, in parts per million, of various ionic constituents of the water to equivalent sodium chloride (NaCl). Using the sum of the equivalent concentrations the resistivity of the water at the desired temperature can be read directly from the curves in Fig. 3. The deviation of calculated resistivities from measured resistivities may be caused by variation in ionic proportions of salts dissolved in the waters.

The multipliers and a sample calculation of a resistivity determination from a water analysis follow:

Ionic constituent	Concentration*	Multipliers	Equivalent concentration of NaCl*
Sodium, Na	58,044	1.0	58,044
Calcium, Ca	20,520	.95	19,494
Magnesium, Mg	2,550	2.00	5,100
Sulfate, SO_4	333	.50	166
Chloride, Cl	133,000	1.00	133,000
Carbonate, CO_3	0	1.26	0
Bicarbonate, HCO_3	0	.27	0
Total	214,447		215,804

Calculated resistivity (using Fig. 3) at 75 F . . = 0.045 ohm-meter
Measured resistivity at 75 F . . . . . = .047 ohm-meter
*parts per million.

Estimating resistivity from the elec-



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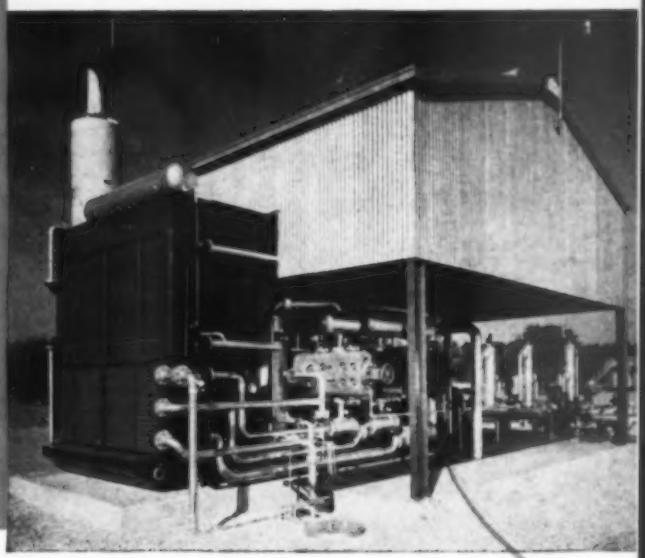

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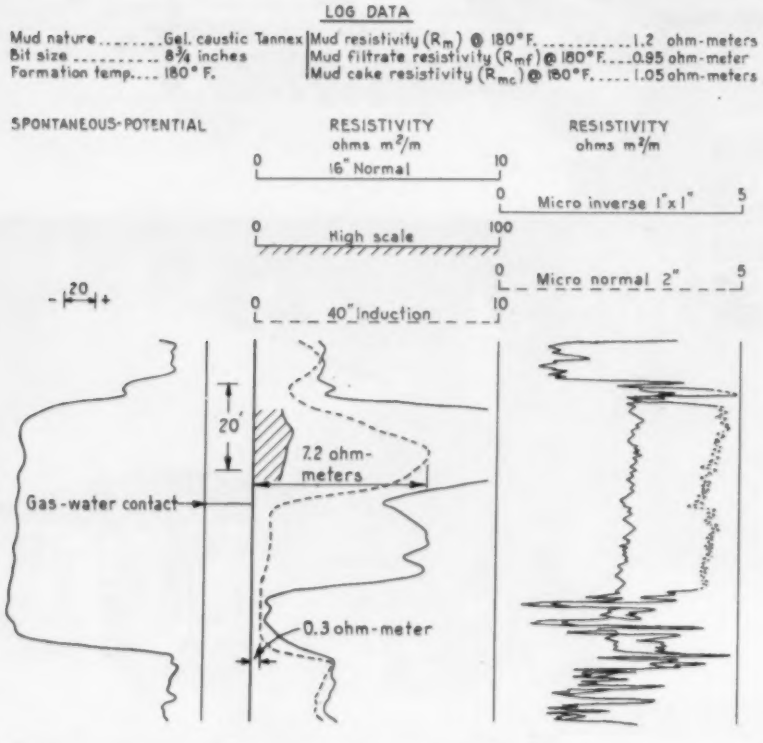

FIG. 4. **Electric-induction and microlog** from the Tuscaloosa formation, Pistol Ridge field, Forrest County, Mississippi.

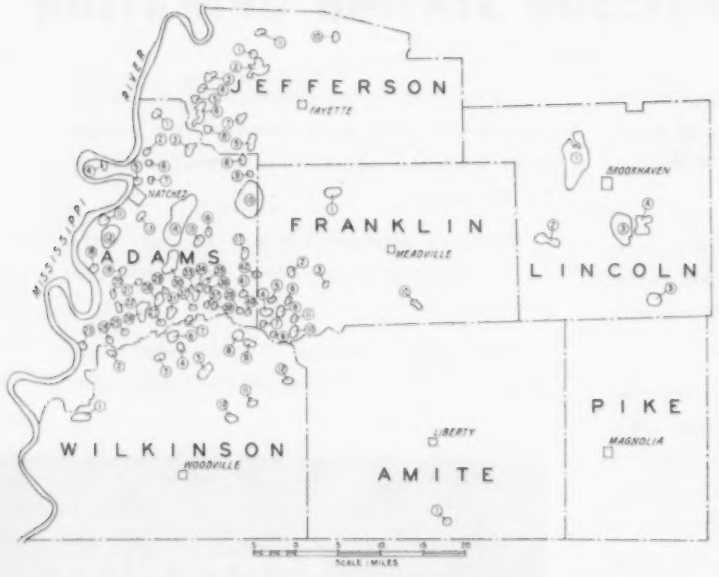

FIG. 5. **Source of water samples** collected in Jefferson, Adams, Franklin, Lincoln, Wilkinson, and Amite counties, Mississippi.

tric logs. Although the practical application of the spontaneous-potential curve (SP) is to distinguish between shale and nonshale formations, the SP curve may also be used quantitatively to estimate the resistivity of formation water. Wylie[6] states that several electrical components are reflected in the SP curve, but the primary potential is of an electro-chemical nature. This relationship is expressed mathematically as follows:

$$SP = K \log_{10} \frac{R_{mf}}{R_w}, \quad . \quad . \quad . \quad (1)$$

where:

SP = magnitude of deflection of self-potential curve from the shale baseline on the electric log, in millivolts;

K = correction factor ranging from −70 to −90 for clean sands, but as low as −50 for shaly sands, and as high as −110 for limestones;

R_{mf} = mud-filtrate resistivity, ohm-m at formation temperature;

R_w = formation-water resistivity, ohm-m at formation temperature.

Several features inherent in this relationship and the K factor (which may vary from −110 to −50) make unlimited use of the equation inadvisable and emphasizes the importance of reliable water resistivity data. However, if the various parameters can be ascertained, a reasonable water resistivity can be estimated by rearranging and solving the equation.

Application in Electric Log Interpretations

The most common use of water resistivity in the quantitative analyses of electric logs is in determining the water saturation of formation rocks. Water resistivity can also be used to calculate porosity when formation rocks are completely saturated with water. To illustrate how these calculations are made, water saturation and porosity are estimated from an electric log of a Mississippi gas well.

The physical rock structure comprising most petroleum-productive formations in the earth is generally considered a poor conductor or nonconductor of electric current. Oil and gas contained within the formation matrix are also nonconductors of electric current. Therefore, any flow of electric current within a formation must take place, with some exceptions,[7] in the interconnected network of a conductive interstitial water. From this it is seen that knowledge of the conductivity or resistivity of the interstitial

General Electric Announces the All-new Type KOF Motor—Only Known Motor with Electrical Characteristics Designed Specifically for Oil Well Pumping

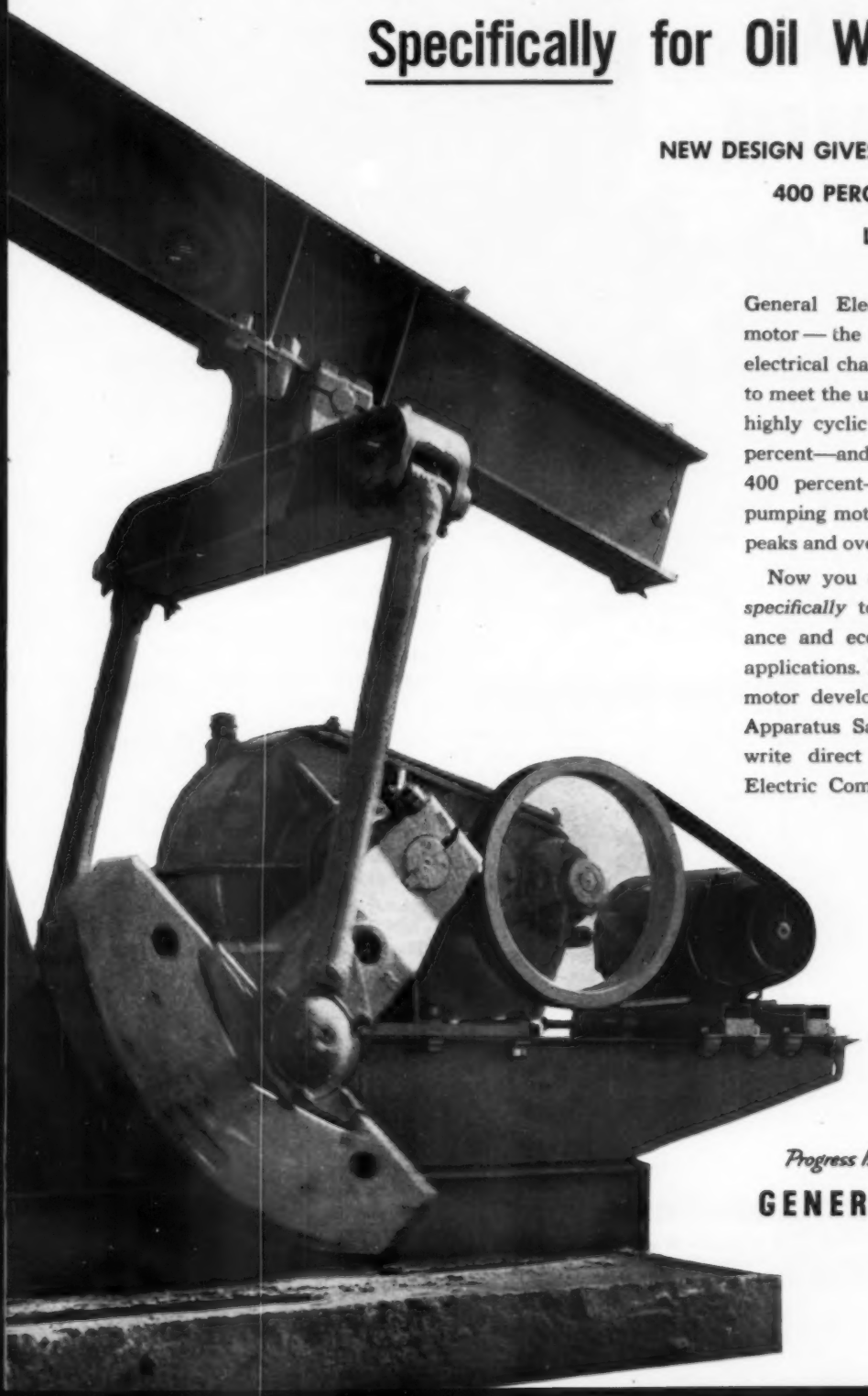

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FIG. 6. **Source of water samples** collected in Yazoo, Hinds, Madison, and Issaquena counties, Mississippi.

FIG. 7. **Source of water samples** collected in Smith, Jasper, Clarke, Jefferson Davis, Jones, Wayne, Lamar, Forrest, Perry, and Green counties, Mississippi.

water is useful in both quantitative and qualitative interpretations of electric logs.

Archie[8] found that the resistivity (R_o) of a clean sand completely saturated with a brine of resistivity (R_w) can be expressed by the following formula:

$$R_o = F R_w, \text{ or } F = \frac{R_o}{R_w} \quad . \quad . \quad (2)$$

where:

F = formation-resistivity factor, which is a complex function of lithology;

R_o = the resistivity of a formation rock when completely saturated with formation water, ohm-m at formation temperature;

R_w = formation-water resistivity, ohm-m at formation temperature.

The formation factor (F) remains essentially constant for any core regardless of the salinity of the saturating brine. It was also shown that, if the saline water contained in the sand is partly displaced by a nonconducting fluid, such as petroleum, the resulting resistivity (R_t) of the sand is empirically related to the descreased water saturation. This relationship is expressed approximately by the following formula:

$$S_w = \sqrt[n]{\frac{F R_w}{R_t}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where:

S_w = formation-water saturation, expressed as a decimal fraction;

n = water-saturation exponent, depending upon the lithology of the rock (usually assumed to equal 2);

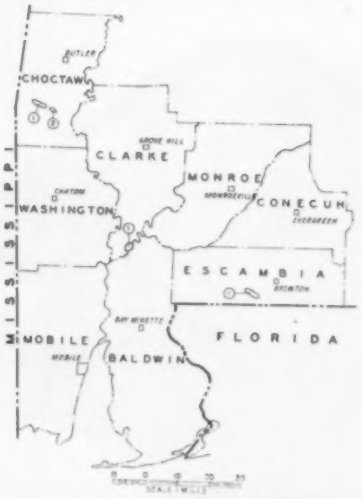

FIG. 8. **Source of water samples** collected in Choctaw, Clarke, and Escambia counties, Alabama.

R_t = true resistivity of the formation, ohm-m.

The formation resistivity factor (F) is also related to the porosity of the sand by the equation:

$$F = P^{-m} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where:

P = porosity of the rock, expressed as a fraction;

m = cementation factor which may vary from 1.3 to 2.2.

Combining Equations 2 and 4 porosity can be expressed as:

$$P = \sqrt[m]{\frac{R_w}{R_o}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Later, Winsauer et al.[9], published what is generally referred to as the "Humble formula" that relates the formation-resistivity factor (F) of a clean sand to its porosity and tortuosity. This equation using the same symbols as in Archie's equations expresses porosity by the following formula:

$$P = \sqrt[2.15]{\frac{0.62}{F}}, \text{ or } P = \sqrt[2.15]{\frac{(0.62)(R_w)}{R_o}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

In the preceding equations it is seen that the basic data needed to solve for water saturation and porosity are: (1) Knowledge of the formation water resistivity (R_w), (2) knowledge of the true resistivity (R_t), and (3) knowledge

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of the formation factor (F). Water resistivity (R_w) may be measured, calculated from mineral analysis of formation brine, or selected from published tables such as presented in this report.

As previously discussed, R_w may be estimated by using Equation 1 ($SP = K_{\log_{10}} R_{mf}/R_w$), provided the various factors and the degree of shalyness can be ascertained. Formation resistivity (R_t) is determined from the apparent formation resistivity, recorded on the electric log.

The apparent resistivity usually requires a correction for one or a combination of disturbing influences which generally prevent R_t from being measured directly. These disturbing influences include: Bore-hole size; mud resistivity; thickness of bed under investigation; interference of adjacent or surrounding beds, and deep invasion of mud filtrate.

Although R_t can usually be determined within reasonable limits, there are some instances where R_t cannot be ascertained with the degree of accuracy necessary to analyze the log quantitatively. The formation factor (F) is usually measured from a core of the well logged but can be obtained from an electrical contact log or a neutron log or be calculated from Equation 2 if R_w and R_o are known.

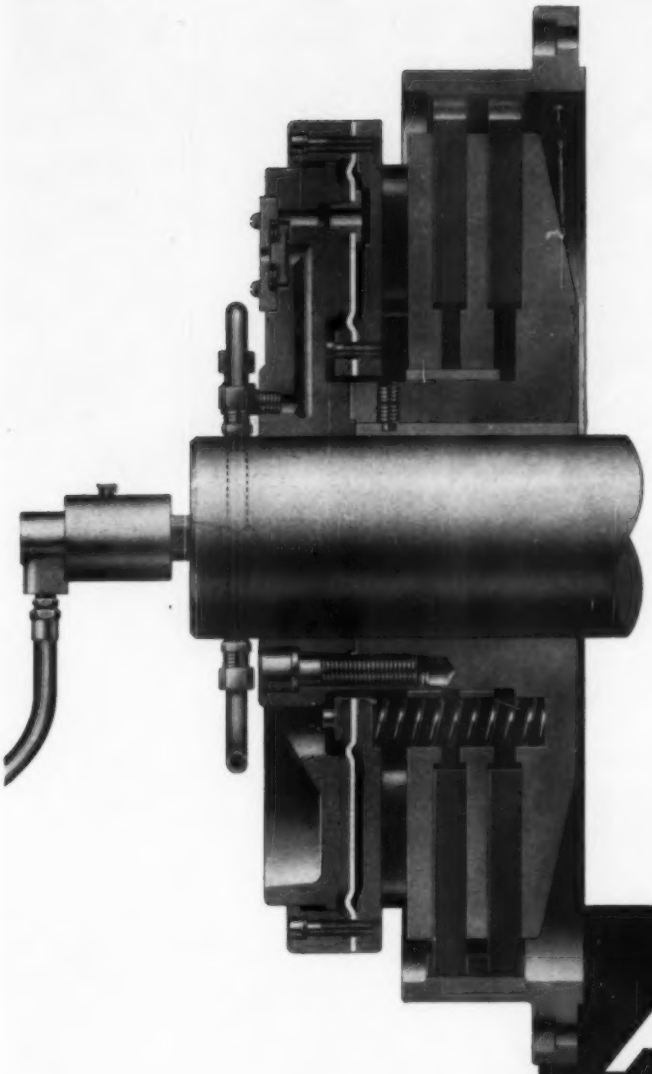
Using the electric log shown in Fig. 4, the true resistivity (R_t) for the productive sand under investigation was determined from the reciprocated induction curve to be 7.2 ohm-m. Average formation resistivity (R_o) was determined from this curve below the gas-water contact to be 0.3 ohm-m. Although some invasion of mud filtrate has taken place, as indicated by the 16-in. normal curve, it is assumed that the apparent formation resistivity as measured by the induction log is near the true formation resistivity (R_t) without correction. Also, in this example it is assumed that the sand has the same physical characteristics above and below the gas-water contact and that the lower section represents the resistivity (R_0) of the sand at 100 percent water saturation.

The formation-water resistivity (R_w) selected from Table 3 equals 0.050 ohm-m. Adjusting this value to formation temperature of 180 F, using curves in Fig. 2, R_w equals 0.021 ohm-m. The formation factor (F), calculated from Equation 2, equals 14.3. Finally, the water saturation exponent (n) was assumed to equal 2.0. Using Equations 3 and 6, water saturation and porosity are calculated as follows:

$$\text{Water saturation} = \sqrt{\frac{(0.021)\ (14.3)}{7.2}} \times 100 = 20 \text{ percent; and}$$

TABLE 1. Resistivity of Water Samples, Jefferson, Adams, Franklin, Lincoln, Wilkinson, and Amite Counties, Mississippi.

Index	Field	Formation	Approximate depth, ft	Av. resistivity R_w at 75 F, ohm-m
		Jefferson County		
1	N. Fayette	Wilcox	3818–3820	0.087
2	Fayette	Wilcox	3800–3950	.086
2	Fayette	Tuscaloosa (Basal sand)	9638–9763	.059
3	Idlewilde	Wilcox (Artman sand)	5267–5278	.063
4	Reeves	Wilcox	5435–5437	.062
5	N. Church Hill	Wilcox (Artman sand)	5423–5436	.062
5	N. Church Hill	Wilcox (Pearline sand)	5395–5398	.062
6	Church Hill	Wilcox (Pearline sand)	5458–5496	.063
7	N. Sunnyside	Wilcox (Stewart "B" sand)	4057–4059	.083
8	Oakwood	Wilcox	5562–5587	.063
9	Sunnyside	Wilcox (4600′ sand)	4163–4164	.082
9	Sunnyside	Wilcox (Artman sand)	5491–5528	.060
9	Sunnyside	Wilcox (Pearline sand)	5511–5563	.061
10	Red Lick	Tuscaloosa (Pilot sand)	9816–9822	.059
11	Brownland	Wilcox	3810–3812	.091
		Adams County		
1	Anna	Wilcox	5637–5638	.060
2	Spring Pond	Wilcox (Armstrong sand)	5736–5742	.060
3	Pine Ridge	Wilcox	5546–5589	.062
4	Cowpen Point	Wilcox	5283–5404	.064
5	Gardens	Wilcox	4270–4480	.082
6	North Natchez	Wilcox (Stewart "B" sand)	4324–4348	.082
7	Homewood	Wilcox	4353–4358	.081
8	Forest Home	Wilcox (4600′ sand)	4266–4272	.082
8	Forest Home	Wilcox (Foster sand)	4250–4263	.060
9	Moss Grove	Wilcox (McKittrick sand)	5816–5818	.059
10	Cranfield	Wilcox (4400′ sand)	4336–4340	.081
10	Cranfield	Wilcox (5535′ sand)	5517–5519	.066
10	Cranfield	Wilcox (5550′ sand)	5485–5494	.065
10	Cranfield	Wilcox (5800′ sand)	5800–5890	.061
10	Cranfield	Tuscaloosa (Lower)	10,220–10,366	.059
11	N. Carthage Point	Wilcox	5826–5858	.063
12	Carthage Point	Wilcox	5975–6059	.064
12	Carthage Point	Tuscaloosa (Lower)	10,230–10,258	.061
13	Natchez	Tuscaloosa (Lower)	10,300–10,320	.064
14	LaGrange	Wilcox (2d sand)	4357–4361	.085
14	LaGrange	Wilcox (4600′ sand)	4623–4625	.082
14	LaGrange	Wilcox (Benbrook sand)	6200–6225	.059
14	LaGrange	Wilcox (Baker sand)	6177–6243	.059
14	LaGrange	Wilcox (N. Wilson sand)	6257–6280	.058
14	LaGrange	Wilcox (S. Wilson sand)	6234–6240	.058
15	Poplar Grove	Wilcox	6322–6324	.059
16	Jeannette	Wilcox	6290–6292	.058
17	Cooper Hill	Wilcox	6229–6232	.062
18	Woodlands	Wilcox	6137–6234	.064
19	New Era	Wilcox	6327–6329	.065
20	Butlers Lake	Wilcox (McKittrick sand)	6280–6282	.065
21	Laurel Hill	Wilcox	6583–6585	.063
22	Glen Aubin	Wilcox	6628–6630	.064
23	East Fairview	Wilcox (Norman sand)	6320–6324	.065
23	East Fairview	Wilcox (Baker sand)	6770–6775	.064
24	Lake Lucille	Wilcox	6736–6742	.056
25	Shieldsboro	Wilcox	6503–6531	.064
26	Sibley	Wilcox (Blake sand)	5857–5860	.073
26	Sibley	Wilcox (Parker sand)	6414–6423	.064
26	Sibley	Wilcox (Robinson sand)	6424–6440	.064
26	Sibley	Wilcox (Ogden sand)	6454–6458	.063
26	Sibley	Wilcox (Ball sand)	6479–6485	.064
27	SE Ellislie	Wilcox	6604–6622	.064
28	Overton	Wilcox (McKittrick sand)	6310–6314	.064
28	Overton	Wilcox (Ogden sand)	6436–6442	.061
28	Overton	Wilcox (Barksdale sand)	6492–6510	.061
28	Overton	Wilcox (Armstrong sand)	6522–6527	.066
29	N. Overton	Wilcox	6274–6277	.064
29	N. Overton	Wilcox	6454–6456	.063
30	S. LaGrange	Wilcox (Ogden sand)	6343–6376	.061
30	S. LaGrange	Wilcox (Parker sand)	6414–6441	.059
31	Mandamus	Wilcox	5685–5691	.079
31	Mandamus	Wilcox	5906–5909	.072
31	Mandamus	Wilcox	6699–6703	.060
32	S. Kingston	Wilcox (Parker sand)	6493–6517	.063
33	Kingston	Wilcox (Baker sand)	6476–6490	.063
33	Kingston	Wilcox (Harmon sand)	6582–6616	.062
33	Kingston	Wilcox (Walker sand)	6635–6640	.061
34	N. Kingston	Wilcox (Baker-Netterville sand)	6503–6509	.062
35	Wayside	Wilcox (2d Wilcox sand)	4631–4643	.087
35	Wayside	Wilcox (Kendall sand)	6496–6546	.061
36	Moorland	Wilcox	6316–6351	.062



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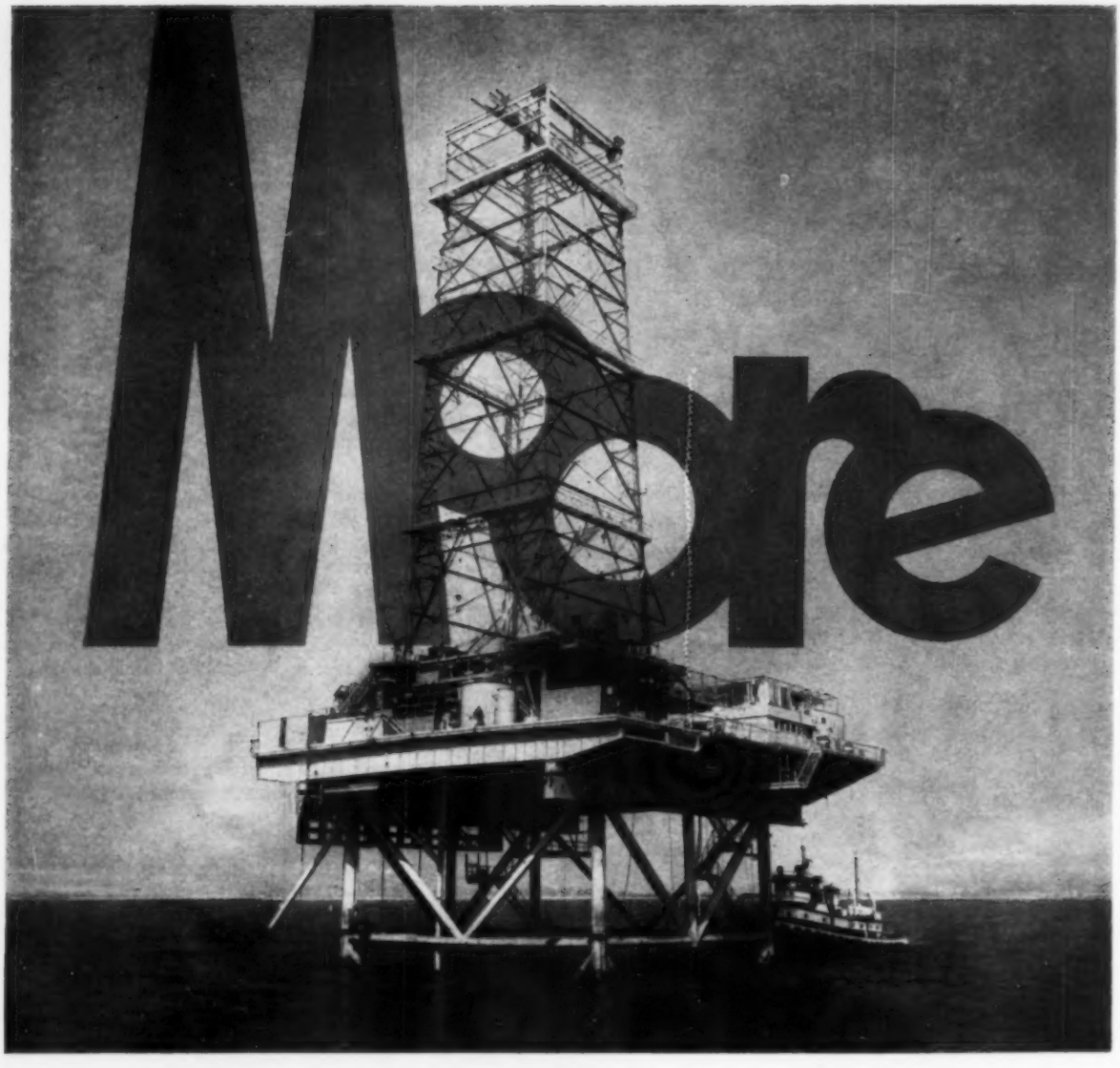

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TABLE 1. — (Continued).

Index	Field	Formation	Approximate depth, ft	Av. resistivity R_w at 75 F, ohm-m
		Adams County (Continued)		
37	Glendale	Wilcox (Minter sand)	6665–6667	.058
38	Courtland	Wilcox	6658–6666	.059
39	Deerfield	Wilcox (Minter sand)	6651–6701	.058
40	Beaver Branch	Wilcox (Minter sand)	6654–6655	.058
41	Levees Creek	Wilcox (Minter sand)	6673–6683	.057
42	Locust Hill	Wilcox	6567–6590	.058
		Franklin County		
1	Oldenburg	Wilcox	5910–5987	.058
2	S. Whiteapple	Wilcox	4623–4632	.080
2	S. Whiteapple	Wilcox	6294–6308	.058
3	Richardson Creek	Wilcox	4694–4695	.081
4	Wells Creek	Wilcox (Baker sand)	6391–6397	.059
5	Flat Rock	Wilcox	6298–6344	.060
6	N. Knoxville	Wilcox (Barksdale sand)	6529–6532	.058
6	N. Knoxville	Wilcox (Walker sand)	6546–6561	.058
7	Dixie	Wilcox	4621–4624	.082
8	Knoxville	Wilcox (Ashley sand)	5985–5987	.064
8	Knoxville	Wilcox	6531–6535	.058
9	Garden City	Wilcox	4664–4666	.083
10	Freewoods	Wilcox	6096–6102	.079
11	N. Freewoods	Wilcox (1st sand)	4590–4617	.086
12	Bude	Tuscaloosa (Lower)	10,950–11,135	.054
		Lincoln County		
1	Brookhaven	Tuscaloosa (Lower Basal)	10,340–10,512	.054
2	W. Lincoln	Tuscaloosa (Lower)	10,590–10,611	.055
3	Mallalieu West	Tuscaloosa (Lower)	10,419–10,489	.052
4	Mallalieu East	Tuscaloosa (Lower)	10,498–10,538	.054
5	Sweetwater	Tuscaloosa (Lower)	10,771–10,806	.054
		Wilkinson County		
1	Lake Mary	Wilcox ("C" sand)	7507–7510	.066
1	Lake Mary	Wilcox (Minter sand)	7649–7653	.065
2	Mills Bayou	Wilcox	6376–6378	.070
3	Doloroso	Wilcox (Minter sand)	6890–6891	.064
4	S. Possum Corner	Wilcox	5091–5093	.091
5	Darrington	Wilcox (Harmon "B" sand)	7027–7094	.063
6	Possum Corner	Wilcox	5083–5086	.087
7	Commencement	Wilcox	6541–6607	.062
8	Ireland	Wilcox	6693–6753	.061
9	Kelly Hill	Wilcox (Armstrong sand)	6549–6565	.063
9	Kelly Hill	Wilcox (Crosby sand)	6687–6690	.062
9	Kelly Hill	Wilcox (Walker sand)	6704–6710	.064
10	Soapstone	Wilcox	7442–7444	.059
11	Mud Creek	Wilcox (McKittrick sand)	7024–7084	.061
12	Tar Creek	Wilcox (McKittrick sand)	6612–6616	.060
		Amite County		
1	Gillsburg	Tuscaloosa (Lower)	11,612–11,635	.058

TABLE 2. Resistivity of Water Samples, Yazoo, Hinds, Madison, and Issaquena Counties, Mississippi.

Index	Field	Formation	Approximate depth, ft	Av. resistivity R_w at 75 F, ohm-m
		Yazoo County		
1	Tinsley	Navarro (Woodruff sand)	4797–4900	0.066
1	Tinsley	Austin (Perry sand)	4830–5290	.064
1	Tinsley	Austin (Stevens sand)	4760–5315	.063
1	Tinsley	Austin (Lammons sand)	5090–5438	.064
1	Tinsley	Eagle Ford (McGraw sand)	5066–5770	.060
1	Tinsley	Eagle Ford (Brumfield sand)	5234–5340	.060
		Hinds County		
1	Bolton	Paluxy	9909–9977	.049
1	Bolton	Glen Rose (Lower)	10,554–10,568	.047
1	Bolton	Glen Rose (Lower)	10,850–10,874	.046
		Madison County		
1	Pickens	Eutaw (Wilburn sand)	4804–4860	.061
2	Flora	Selma Gas Rock (Anderson sand)	4363–4371	.068
		Issaquena County		
1	Valley Park	Rodessa	6136–6148	.050

$$\text{porosity} = \sqrt[2.15]{\frac{(0.62)\ (0.021)}{0.3}} \times 100 = 23 \text{ percent.}$$

Average porosity was also calculated from the micro-log shown in Fig. 4, using the general procedure published by Doll,[10] with appropriate interpretation charts,[11] to be about 20 percent.

The average porosity determined by core analysis from the top 10 ft of this sand is 21.7 percent. Water saturation determined by the "restored state" method on several cores from adjacent wells indicate that the minimum water saturation above the gas-water transition zone is about 16 percent.

Index Maps and Tables

Maps of counties (Fig. 5 through 8) show the geographical locations of the oil fields from which water samples were obtained for this survey. Index numbers on the maps refer to the general location of the fields in each county and not to the exact location within the fields where the samples were collected. The average water resistivity for each productive formation corresponding to the index numbers is given for each field in Tables 1 through 4. These tables also give the name of the field, the formation, subproducing zone (if known) and approximate depth of the formation from which water was sampled.

Summary

Interpretation of electric logs is generally regarded as a combination of an art and a science that can be developed only by experience. Knowledge of formation characteristics and their effects on well logs as well as a knowledge of the theory of electric logging and its limitations are a great help because assumptions are often necessary in the course of this work. More available information reduces the number of assumptions and increases the range of reliable interpretations that can be made by a log analyst. It is toward this end, that this report has been prepared to provide water-resistivity data essential in interpreting electric logs.

The report includes water-resistivity data from the major oil-productive formations in Mississippi and Alabama. Resistivity of formation waters from this area range from 0.110 to 0.044 ohm-m at 75 F. Resistivity generally decreases with depth of the formation, although direct correlation with depth is not apparent in any formation sampled. A study of the data shows that within localized areas lateral variations in resistivity of formation water are usually small. Therefore, reasonably reliable resistivity for formation water in fields and areas not included in the report can be estimated by interpolating

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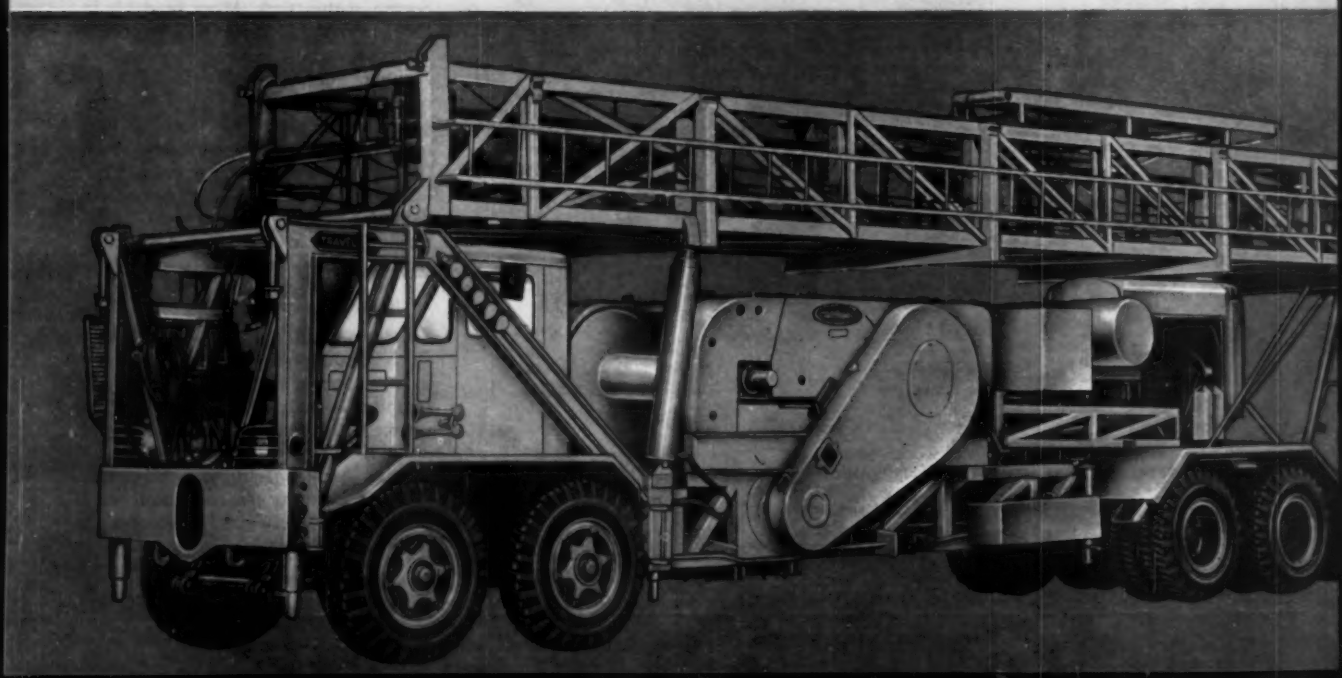

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TABLE 3. Resistivity of Water Samples, Smith, Jasper, Clarke, Jefferson Davis, Jones, Wayne, Marion, Lamar, Forrest, Perry, and Green Counties, Mississippi.

Index	Field	Formation	Approximate depth, ft	Av. resistivity R_w at 75 F, ohm-m
		Smith County		
1	Raleigh	Hosston	12,190–12,250	0.047
		Jasper County		
1	W. Heidelberg	Eagle Ford (Stanley sand)	5072–5082	.060
1	W. Heidelberg	Eagle Ford (Christmas sand)	5294–5296	.059
2	E. Heidelberg	Eagle Ford	4674–5014	.061
2	E. Heidelberg	Tuscaloosa (Upper)	4936–5005	.061
		Clarke County		
1	Langsdale	Eutaw	3644–3771	.072
		Jefferson Davis County		
1	Gwinville	Eutaw and Tuscaloosa (Upper)	7875–8120	.054
1	Gwinville	Tuscaloosa (Gholar sand)	8712–8720	.052
1	Gwinville	Tuscaloosa (Lower)	9190–9196	.049
		Jones County		
1	Soso	Eagle Ford (Stanley sand)	6498–6518	.056
1	Soso	Eagle Ford (Christmas sand)	6610–6630	.055
1	Soso	Rodessa (11,090 sand)	11,372–11,384	.044
1	Soso	Rodessa (11,151 sand)	11,492–11,510	.045
1	Soso	Rodessa (11,180 sand)	11,504–11,509	.045
1	Soso	Rodessa (11,385 sand)	11,691–11,720	.047
1	Soso	Sligo (11,701 Bailey sand)	11,966–12,045	.044
2	Sharon	Eutaw	5546–5605	.057
3	Sandersville	Eagle Ford (Christmas sand)	5558–5607	.059
4	Gitano	Paluxy	11,280–11,286	.046
5	Ovett	Eutaw	7310–7351	.052
		Wayne County		
1	West Eucutta	Eagle Ford	5208–5272	.059
2	East Eucutta	Eagle Ford	5027–5097	.061
2	East Eucutta	Eagle Ford (Stanley and City Bank sands)	5219–5260	.060
3	N. Yellow Creek	Eutaw	4705–4746	.064
4	W. Yellow Creek	Eutaw	5022–5159	.062
5	E. Yellow Creek	Eutaw	4598–4954	.063
6	Diamond	Glen Rose	9227–9454	.049
6	Diamond	Hosston	9355–9367	.046
7	Chaparral	Eutaw	4305–4317	.068
7	Chaparral	Cretaceous (Lower)	9486–9608	.047
		Marion County		
1	Hub	Tuscaloosa (Lower)	9125–9130	.047
2	Sandy Hook	Tuscaloosa (Lower)	8988–9020	.053
		Lamar County		
1	Baxterville	Eutaw	7932–8010	.055
1	Baxterville	Tuscaloosa (Lower)	8734–8850	.049
		Forrest County		
1	Pistol Ridge	Eutaw	7412–7471	.057
1	Pistol Ridge	Eutaw (Hatten sand)	7414–7417	.057
1	Pistol Ridge	Tuscaloosa (Crow Creosote sand)	7500–7504	.056
1	Pistol Ridge	Tuscaloosa (Stevens sand)	8400–8466	.052
1	Pistol Ridge	Tuscaloosa (Massive sand)	8520–8600	.050
1	Pistol Ridge	Cretaceous (Pigford sand)	9080–9100	.053
1	Pistol Ridge	Cretaceous (Nelson sand)	9610–9612	.050
1	Pistol Ridge	Cretaceous (Lower)	9613–9686	.048
1	West Pistol Ridge	Paluxy	10,958–10,964	.049
2	Maxie	Eutaw	7243–7307	.060
2	Maxie	Tuscaloosa (Lower)	8172–8414	.052
		Perry County		
1	Glazier	Tuscaloosa (Upper)	7058–7174	.055
		Greene County		
1	Sand Hill	Tuscaloosa (Upper)	7804–7812	.051

TABLE 4. Resistivity of Water Samples, Choctaw, Clarke, and Escambia Counties, Alabama.

Index	Field	Formation	Approximate depth, ft	Av. resistivity R_w at 75 F, ohm-m
		Choctaw County		
1	Gilbertown	Selma Chalk	2560–2700	0.110
1	Gilbertown	Eutaw	3500–3600	.090
2	East Gilbertown	Selma Chalk	2300–2325	.101
2	East Gilbertown	Eutaw	3336–3400	.099
		Clarke County		
1	South Carlton	Tuscaloosa (Pilot sand)	5320–5335	.058
1	South Carlton	Tuscaloosa (Massive sand)	5420–5450	.057
		Escambia County		
1	Pollard	Tuscaloosa (Miller sand)	5806–5825	.056
1	Pollard	Tuscaloosa (Moye sand)	5944–5960	.055
1	Pollard	Tuscaloosa (Massive sand)	5980–6025	.054

the presented data for nearby fields. However, care should be exercised when interpolating data where subsurface conditions, such as extreme faulting, may radically alter the geology of the area under study.

Resistivities presented in this report were checked by comparison for possible errors, and doubtful values were omitted from the average resistivity shown in the tables for each formation water. Before using these data, it should be remembered that the resistivities must be adjusted to the temperature of the formation under investigation.

Acknowledgments

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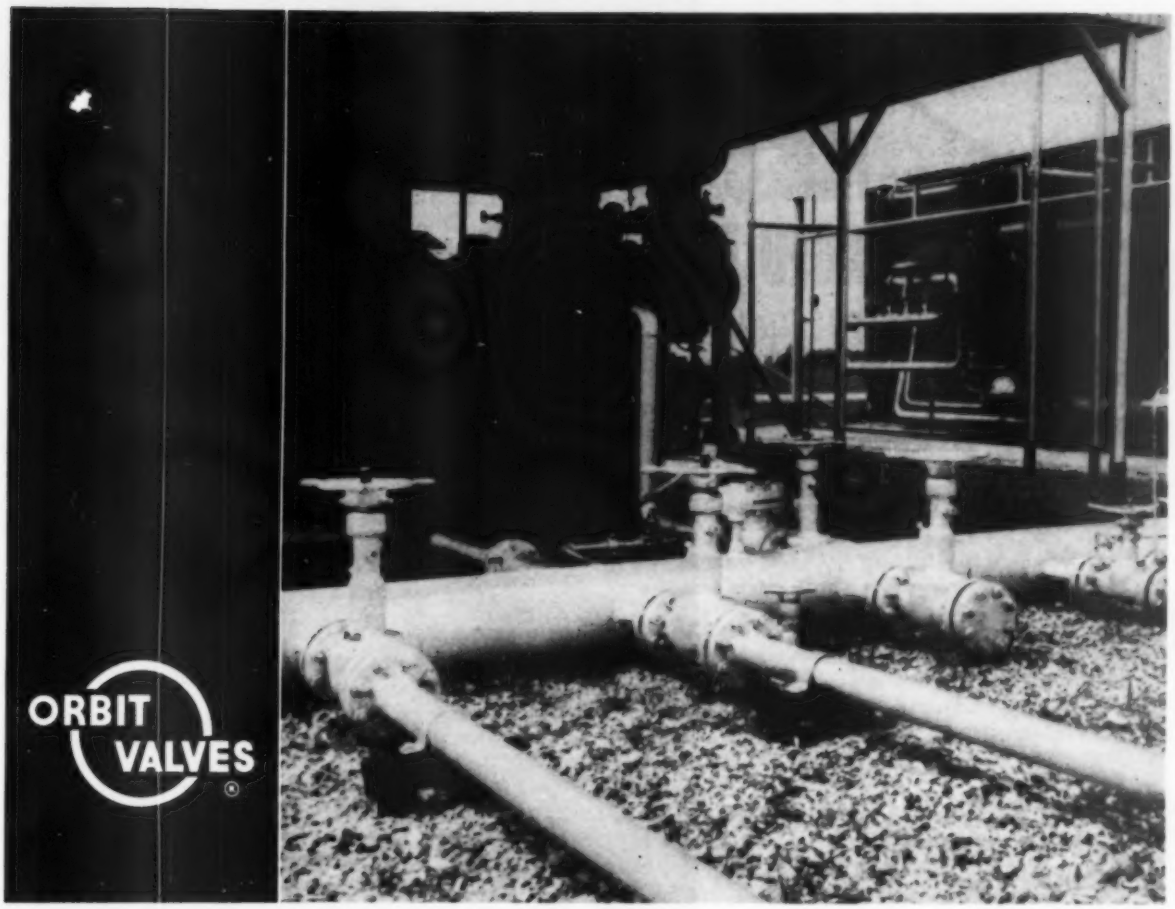
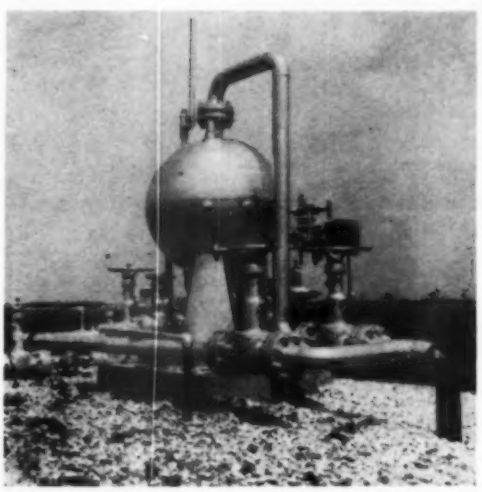
QUALITY AND RELIABILITY AT WORK



ORBIT FORGED STEEL VALVES ARE NON-LUBRICATED

and built for continuous heavy-duty service



Orbit valves shown in picture at top are installed in compressor discharge service. This is a tough service where velocities and vibration would play havoc with most valves — but not with Orbit valves, because they are built to withstand continuous heavy-duty service.

WRITE FOR CATALOG 58-B COVERING ASA CLASS VALVES OR CATALOG 58-A COVERING PRODUCTION VALVES.

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WAREHOUSES: HOUSTON, TEXAS, 407 Velasco, CApitol 8-6623, TWX HO 115; ODESSA, TEXAS, 402 West County Road, FEderal 7-2263, TWX ODESSA TEX 8706; LAFAYETTE, LOUISIANA, 3111 Cameron St., CEnter 4-3326; CASPER, WYOMING, 414 South Elm Street, Phone 2-1324; EDMONTON, ALBERTA, CANADA, 7119-104th St., Phone 391-283. WEST COAST REPRESENTATIVES: Charles Lowe Company, 383 Fourth Street, San Francisco, Calif.; Marshall E. Niedecker Company, 2785 Cherry Ave., Signal Hill, Calif. CANADIAN REPRESENTATIVES: T. R. Pickford & Company, Ltd., Calgary, Alberta, 309 7th Avenue West; Amherst 2-7371. EXPORT REPRESENTATIVE: New York 36, N. Y., 500 Fifth Avenue, BRyant 9-2236

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OF THE GROUND BELOW THE RIG

There's no need for second guessing about productive strata when the evidence is right before your eyes. The new rubber sleeve core barrel delivers cores in a complete package even in soft, unconsolidated formations.

Formerly, soft formation cores were unobtainable due to grinding and drilling fluid wash. Now the rubber sleeve wraps them tightly, keeps them intact, and offers maximum protection against washing, blocking or friction grinding. Cores are delivered, "packaged as cut," ideal for analysis, handling and shipping.

Every dollar you invest in a well is spent for the sole purpose of discovering oil. For minimum risk in exploration, you must evaluate the formation below the rig. The only sure method of formation evaluation is coring. The development of the Rubber Sleeve Core Barrel has greatly expanded the area in which you can obtain the vital information you need to determine a productive field. With the addition of the soft formation rubber sleeve core barrel to a complete line of conventional and wireline barrels, Christensen has a core barrel to fit your needs, regardless of the formation type.

Call the Christensen representative nearest you and get the "Hole" story.

For more detailed information on the rubber sleeve core barrel, ask for RS-801. For additional information on conventional or wireline core barrels, ask for CB-608.
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Diamonds Mean, "Less cost per foot."

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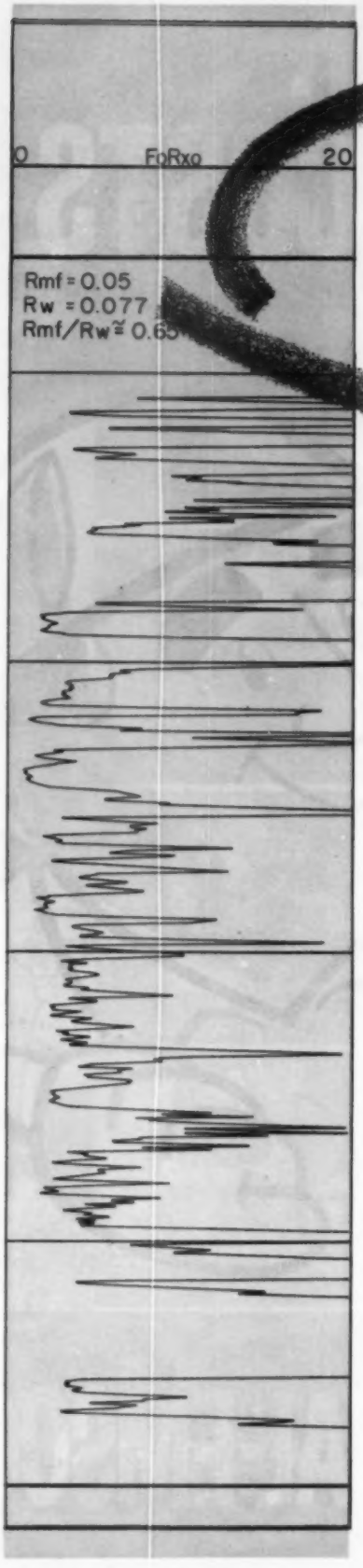

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(Focused Resistivity)

Porosity Determination is Simple with Welex FoRxo Log

There is no other logging device in the oil field today that can so accurately distinguish vertical changes in lithology as the Welex FoRxo. This logging device, as its name implies, measures directly the resistivity of the flushed mud filtrate invaded zone—Rxo. At the same time, it also records an SP curve and a Caliper curve.

By focusing current from a pad which is held against the side of the hole, the measurement of Rxo is accomplished. The conversion of Rxo to porosity is a simple step.

The Welex FoRxo Log, in conjunction with the Welex Guard Log (which is focused deep in the formation to read true resistivity—Rt) provides an unbeatable Production Guide for those difficult-to-analyze wells where formations and mud resistivities are similar. Thin beds, shaly sands, rapid lithological changes all are easier to analyze with this combination of Welex logs.

The Welex FoRxo Log is another Welex Production Guide that has earned the confidence of oil men everywhere.

Well Experienced

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EQUALIZER

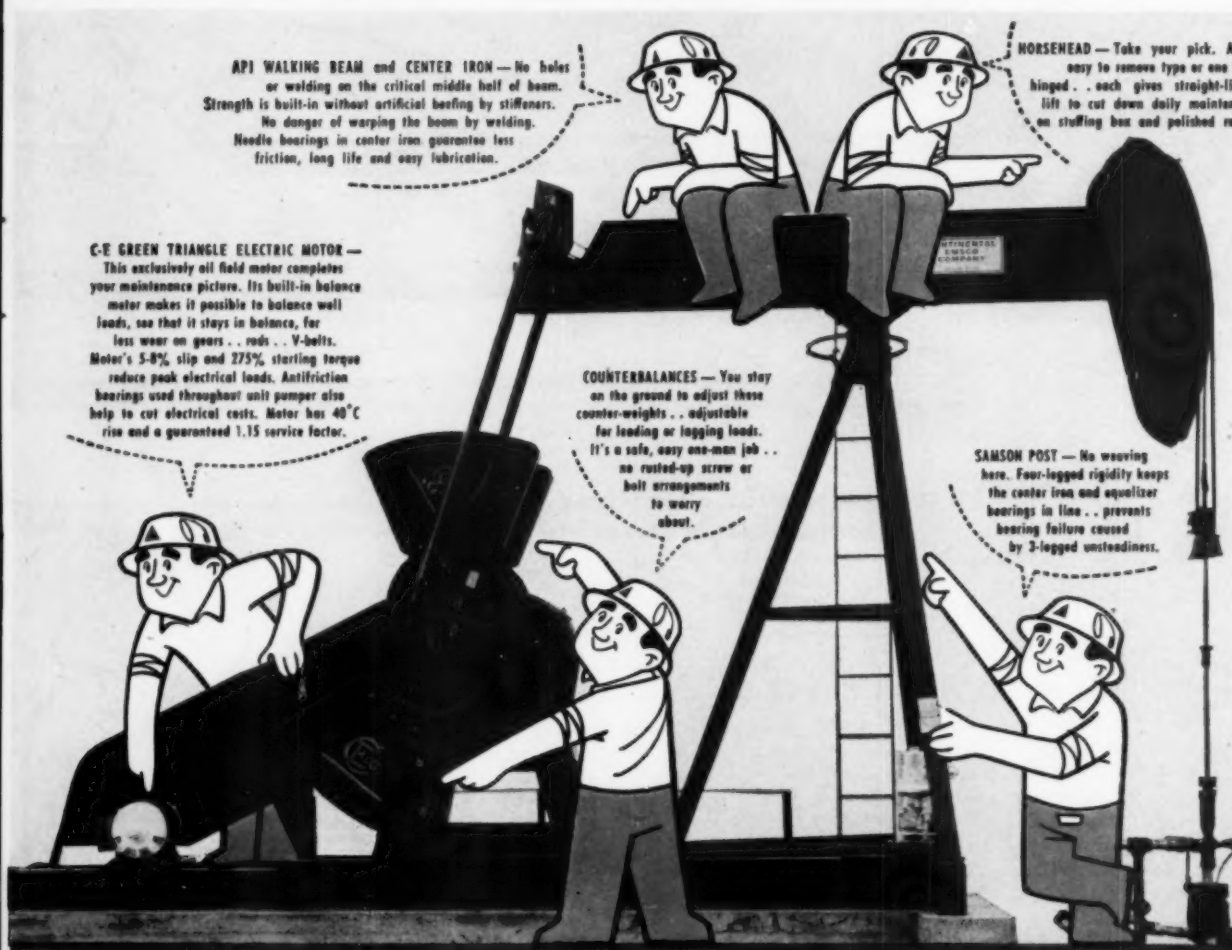
Designed specifically for this job . . fabricated for rigidity and long life to assure equal sharing of well loads by pitmans.

CENTRALIZED LUBRICATION

It's a *one-position,* safe operation to grease center iron and equalizer assemblies from the ladder and safety-ring positi ground-level lubricating assemb available.

WRIST PIN

Pin wear and damage are eliminat the use of completely enclosed, antifr bearings . . no bushings. Special loc


API WALKING BEAM and CENTER IRON — No holes or welding on the critical middle half of beam. Strength is built-in without artificial beefing by stiffeners. No danger of warping the boom by welding. Needle bearings in center iron guarantee less friction, long life and easy lubrication.
HORSEHEAD — Take your pick. A easy to remove type or one hinged . . each gives straight-li lift to cut down daily maintar on stuffing box and polished ro
C-E GREEN TRIANGLE ELECTRIC MOTOR — This exclusively oil field motor completes your maintenance picture. Its built-in balance motor makes it possible to balance well loads, see that it stays in balance, for less wear on gears . . rods . . V-belts. Motor's 5-8% slip and 275% starting torque reduce peak electrical loads. Antifriction bearings used throughout unit pumper also help to cut electrical costs. Motor has 40°C rise and a guaranteed 1.15 service factor.
COUNTERBALANCES — You stay on the ground to adjust these counter-weights . . adjustable for loading or lagging loads. It's a safe, easy one-man job . . no rusted-up screw or bolt arrangements to worry about.
SAMSON POST — No weaving here. Four-legged rigidity keeps the center iron and equalizer bearings in line . . prevents bearing failure caused by 3-legged unsteadiness.

for Service

NCE COST . . NOT JUST BUILT UMPERS

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pick. A simple,
or one that's
raight-line
maintenance
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positively prevents loosening of wrist pin in crank holes. Removable wrist pins are hydraulically ejected.

BELT GUARD

This guard is of heavy sheet metal . . not tin. It gives you *real* safety and protection.

PITMANS

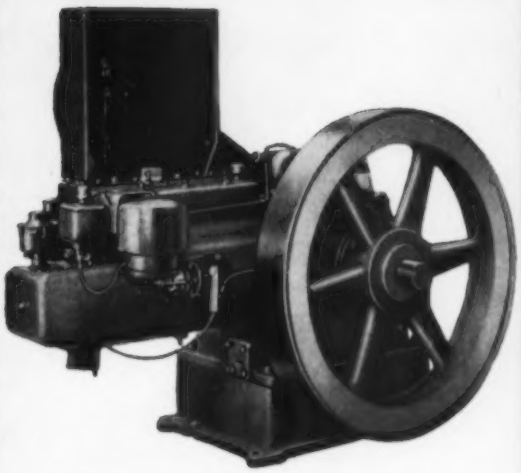
Take a look at these solid, one-piece, banjo-type lower connections . . no bolt or hinge failures here.

MAIN BASE

Extra heavy beams hold complete unit, so that all component parts are held in place without flexing or twisting . . thus assuring maximum stability under loads for which they were designed.

API GEAR REDUCER

One-piece box design carries well loads in frame, not on the bolts . . reduces oil leaks . . makes it easy to inspect gears without disturbing bearing arrangement. No mechanical seals to wear out and require replacing. Precision cut gears (not lapped) permit partial replacement of gear train *in the field* when necessary. Regardless of speed or direction of rotation, gears and bearings are completely lubricated. Two sumps guarantee clean oil.



SAVE your MAINTENANCE DOLLARS with C-E PUMPING ENGINES

Routine maintenance, checking or adding oil and water . . as well as making many engine adjustments are extremely easy to do . . *can even be done with the engine running.* Unit assemblies are used. They can be installed without disassembling the engine, to save valuable man hours and production time. Major items . . wet-type cylinder liner, valve guides and inserts, piston and bearings . . can be replaced for many additional years of dependable pumping. An "on-location" overhaul is possible.

that Sings . .

Accurately gauging internal diameter of tube (also one-piece liners) to assure close working tolerances and reduce possibility of future pulling jobs.

Making up barrel tubes (also cages) with friction tongs prevents damage to pump parts and eliminates danger of corrosion and high stresses caused by pipe wrench marks.

Measuring with micrometer assures close tolerances of plungers in repaired pumps. Properly fitted plungers keep pump at maximum efficiency.

Determining internal diameter of sectional liners with stop plug gauge. Exacting tolerances assured for pumping efficiency.

Testing ball and seat with vacuum-type tester for perfect sealing to eliminate costly pulling jobs caused by faulty valves.

THE RIGHT TOOLS IN THE RIGHT HANDS IN C-E PUMP SHOPS SAVE YOUR SUBSURFACE PUMP MAINTENANCE DOLLARS

PUMPS D+B SALES SERVICE

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PREVENT ROD FAILURES

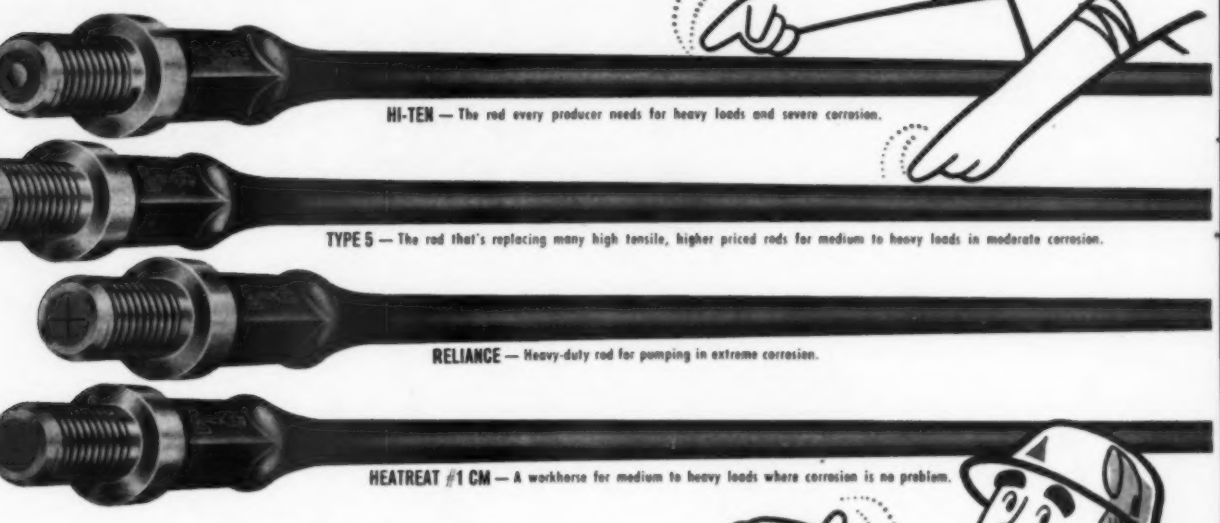
With the right Continental - Emsco D+B sucker rod

Having too many pin breaks? Corrosion eating up rods . . profits? Would a tapered string reduce initial costs? These and many other sucker-rod-application questions are answered daily by Continental-Emsco specialists. Every answer means *lower-cost production* and *increased profits.* Get the *right* answers yourself. See Continental-Emsco today.

VANADIUM IN THESE RODS CUTS SUCKER ROD FATIGUE

Of course vanadium is in our HI-TEN rod for its amazing *load carrying* qualities.

But did you know vanadium is also in our Type 5 rod? It is! And, it adds so much extra strength that the Type 5 is replacing many so-called "high-tensile" rods selling at higher prices. Give Type 5 a try . . it'll save your production dollars.



HI-TEN — The rod every producer needs for heavy loads and severe corrosion.

TYPE 5 — The rod that's replacing many high tensile, higher priced rods for medium to heavy loads in moderate corrosion.

RELIANCE — Heavy-duty rod for pumping in extreme corrosion.

HEATREAT #1 CM — A workhorse for medium to heavy loads where corrosion is no problem.

WE PAINT 'EM ALL WITH OIL SOLUBLE PAINT

A nick in an enamel or plastic covered rod is an open window for corrosive pitting and premature rod failure.

That's why we use a paint that dissolves as soon as it hits the oil. This eliminates all open spots, so there is no concentrated corrosive attack. The main purpose of our paint is to protect the rods from atmospheric corrosion and above-ground handling.

t that Hums

..BACKING UP C-E SERVICE with TRAINED MEN

EXPERIENCED SUPERVISION

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At Continental-Emsco you'll find extra *service-hands* to supplement your own maintenance crews . . well-equipped pump shops to keep *all* your subsurface pumps at top operating efficiency . . experienced field service men with the finest in oil field products. Plant-to-field engineering liaison keeps field personnel fully informed on new and improved product design and application.

To keep your production equipment *humming for years* . . go Continental-Emsco for the lowest possible maintenance costs.

For Service that Sings . . Equipment that Hums . . Go . .

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P828

..Go CONTINENTAL-EMSCO

Capacitors, installed with beam pumping unit motors are

Reducing Power Costs In Lease Electrification

- *Improved system power factors bring direct savings in power costs, lower distribution and secondary conductor requirements*
- *Better voltage levels, better starting torques and operating characteristics due to 25 percent reduction in secondary voltage drop*
- *44 percent reduction in secondary system I^2R losses*

John H. Day, Jr.
General Electric Company
Dallas, Texas

FIG. 1. **Newly completed pumping well** southwest of Levelland, Texas, is getting the most from each power-dollar invested. Alongside the controller box on the stub power pole is being installed a capacitor — to improve the system power factor.

OVER HALF of the first cost of lease electrification is represented by the distribution system; the rest being the motor and controller. Since the size and requirements of the motor and its controller are relatively fixed, little can be done to gain economy or efficiency in the utilization apparatus. It is therefore in the lease distribution system where most engineering considerations affecting economy and efficiency of operation can be expected.

System Design

There are certain criteria of operation of a well designed lease electrification system, which are:

1. The overall voltage drop for the system including primary lines, distribution transformers, and secondary feeder should not exceed 15 percent maximum, measured from point of power delivery to the lease to the motor farthest from transformer bank, and including power supply voltage regulation (usually 5 percent).
2. An operating voltage of not less than 95 percent of nameplate rating during running, and not less than 80 percent nameplate rating during starting for motor farthest from transformer bank.
3. An overall system average power factor at higher than 80 percent minimum.

Voltage drop and system power (I^2R) heating losses can be minimized by oversizing the transformers and conductor, or by overvoltaging the system secondary. The first method is expensive, of course, and the latter decreases insulation life of the equipment.

A better, more economical way of minimizing voltage drop and system I^2R heating losses is to use capacitors to improve system power factor.

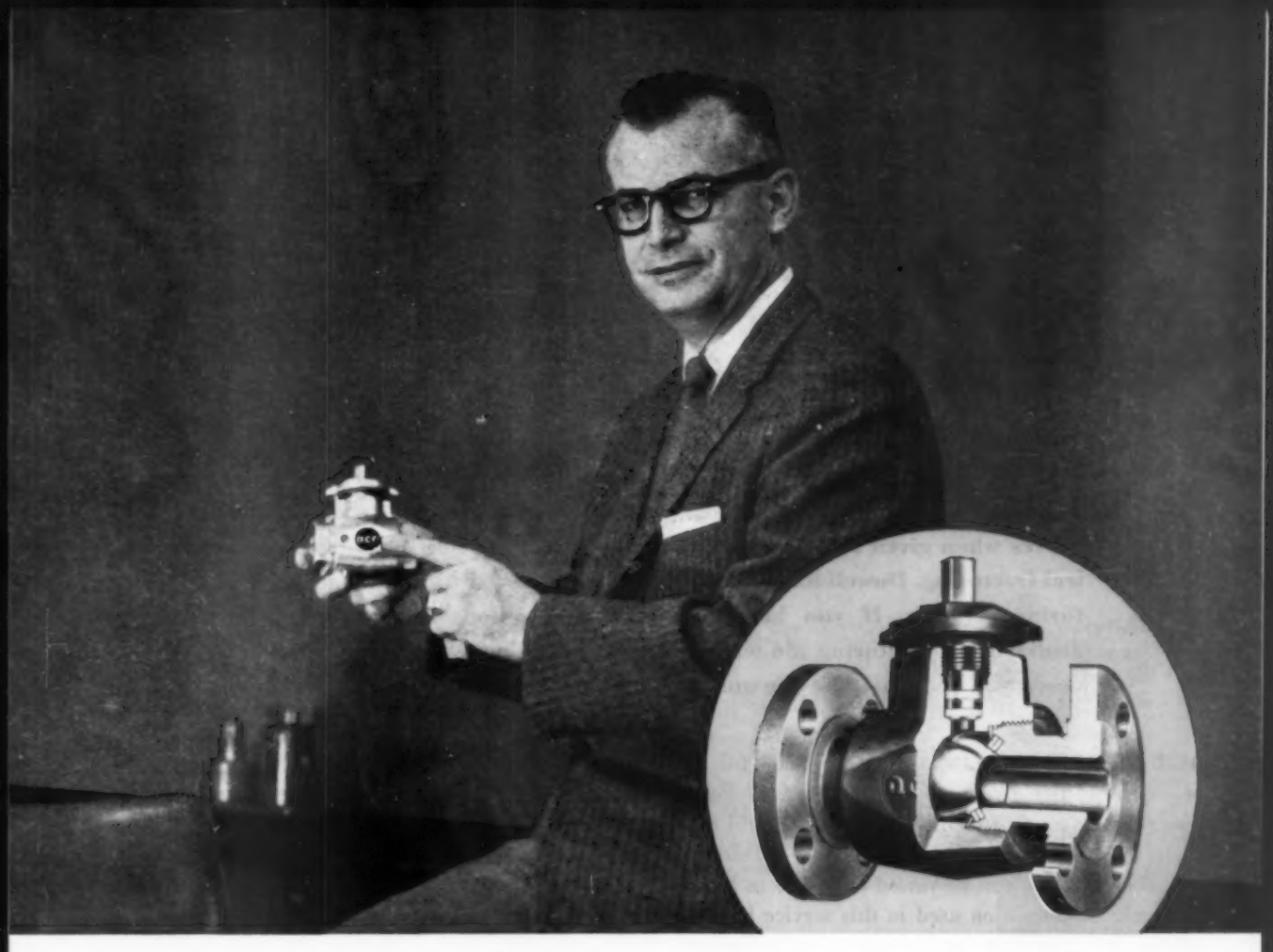
Capacitors applied to oil well pumping motors can increase efficiency and produce economies by:

1. Reducing system distribution investment, usually by 10 to 12 percent.
2. Reducing the power lost in the distribution system by as much as 44 percent.
3. Improving voltage levels by reducing voltage drop, giving better motor operating torques.

In power contracts where a power factor adjustment clause is included and enforced as part of the power billing, they can also help to substantially reduce the cost of power.

In addition, power factor improvement by reducing line current can produce savings by decreasing the transformer and feeder capacity needed to serve the load.

Fig. 2 demonstrates how a capacitor reduces line current. When properly sized to the motor, the capacitor will cancel out most of the out-of-phase magnetizing component of the motor line current, since the capacitor draws current exactly out-of-phase or electrically opposite to the motor magnetizing



You should know more about the new ACF non-lubricated Ball Valve

Now, while you're thinking about it, ask your secretary to have us send you Catalog 1000.

This catalog will give you a full description of the latest product of W-K-M's creative engineering—the ACF non-lubricated Ball Valve.

This new valve was service-tested for 3½ years before it was offered to buyers. Service-*tested* and service-*proved*: in the entire 3½ years, every user reported completely satisfactory results.

It's a great valve, this new one: versatile, rugged, efficient, easy to maintain on those rare occasions when maintenance becomes necessary, a valve you can specify with complete confidence.

So send for Catalog 1000—you should know more about this *new* valve.

Product of W-K-M's *Creative Engineering*

This cut-away picture shows you why this new valve performs so dependably, lasts so long, and is so economical to maintain.

Note the full, round conduit through body and ball that assures full flow through the valve—without turbulence, and with no more pressure drop than through an equivalent length of pipe.

Note the way the ball is suspended between Teflon seats under compression, assuring leakproof service at rated working pressures, or under vacuum, indefinitely.

Note the way actual seating surfaces are sealed away and protected from any abrasive action of the lading flow in either open or closed position.

Available in carbon steel (ASA 150 lb., 300 lb.), and semi-steel (200 lb., 400 lb.). Sizes range from ½" through 6". See Catalog 1000 for full listing of sizes and pressures.

W-K-M

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5817

DOWELL OFFERS FOUR COMBINATION ACID/FRACTURING SERVICES—HERE'S WHY

There are many cases where formations do not respond well to either acidizing or fracturing treatments alone. Frequently, however, these same formations show high production increases and flatter decline curves when given a treatment combining chemical acidizing and mechanical fracturing. Dowell has developed and field-proved four such acid/fracturing services. If you have had poor production results with either acidizing or fracturing alone, one of the Dowell acid/fracturing services, described here, may be the answer to your specific well problem.

ACID PETROFRAC*—Developed primarily for use in limestone and dolomitic formations, Acid Petrofrac employs an acid-in-oil emulsion. The fluid may be mixed to almost any desired thickness, and the acid concentration can be varied from one to fifteen per cent. The emulsion used in this service has low friction loss and excellent sand-carrying properties. Its retarded acid properties allow deep penetration before spending, and its silicate control properties are designed to provide clean flow channels for better, longer-life wells.

DUOFRAC*—This new Dowell service was developed especially for use in limestone and dolomite formations containing salt. Duofrac uses fresh water, light acid concentrations, and sand. The water in Duofrac acts to dissolve the salt present, while the dilute acid attacks the limestone or dolomite. The amount of acid used in each treatment depends on the characteristics of the producing formation. Treatments are usually made with large volumes and at high-injection-rates.

FRAC ACID*—Developed for use in formations of relatively high solubility, Frac Acid employs thickened, inhibited hydrochloric acid carrying suspended sand. After a controlled length of time, the thickened fracturing fluid reverts to water thinness. The sand is retained in the formation. Frac Acid contains more acid by volume than any other acid/fracturing service offered by Dowell.

STRATAFRAC*—Stratafrac uses an acid-kerosene emulsion with sufficient body to carry sand in suspension. The materials used in this service may include agents to reduce silicate swelling, and to dissolve clay and silicate particles in the formation. The acid concentration and the size and amount of sand used in Stratafrac can be tailored to fit formation conditions.

For more information on Dowell's acid/fracturing services, contact your local Dowell engineer. He will help you select the service best suited to the conditions of your well. Call any of the 165 Dowell service points. In Canada, contact Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Or write Dowell, Tulsa 1, Oklahoma.

*DOWELL SERVICE MARK

Services for the oil industry DOWELL

A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

DOWELL

BARBER COUNTY, KANSAS:
Although only slightly soluble in acid, the Mississippian chat formation responds well to Acid Petrofrac. Typical treatment: 1000 gallons fluid and 1000 pounds sand per foot of perforation, injected at 30 bpm. Results on gas wells are often ten times drill stem test.

YOUNG COUNTY, NORTH TEXAS:
Frac Acid usually obtains good results in the Caddo lime formation. Treatment example: 10,000 gallons 10 per cent thickened acid and 10,000 pounds sand, preceded by 500-gallon spearhead of Mud Acid. Treating material injected down casing at average rate of 33 bpm at 2200 psi maximum.

LINCOLN PARISH, NORTH LOUISIANA:
Stratafrac is often used in the Hosston formation with excellent results. It is designed to clean up fast and to suspend sand well at high temperatures. Recent treatment example: A new well was treated with 8500 gallons acid-kerosene emulsion, 2000 gallons low-surface-tension acid and 12,000 pounds sand. Pressures ranged from 4000 psi minimum to 6200 psi maximum. After treatment, initial open flow was 4100 mcfpd.

ECTOR COUNTY, WEST TEXAS:
In the Goldsmith Clearfork formation of the Permian Basin, Duofrac is frequently the answer to difficult production problems. A recent example: Before treatment the well would not produce. Dowell used a four-stage treatment — (1) 500 gallon spearhead of Mud Acid, (2) 10,000 gallons fresh water with de-emulsifying agent, (3) 25,000 gallons 7½ per cent acid with de-emulsifying agent and 25,000 pounds sand, and (4) 10,000 gallons fresh water with de-emulsifying agent as a flush. Potential after 35 days was 360 bopd. After 95 days, 273 bopd.

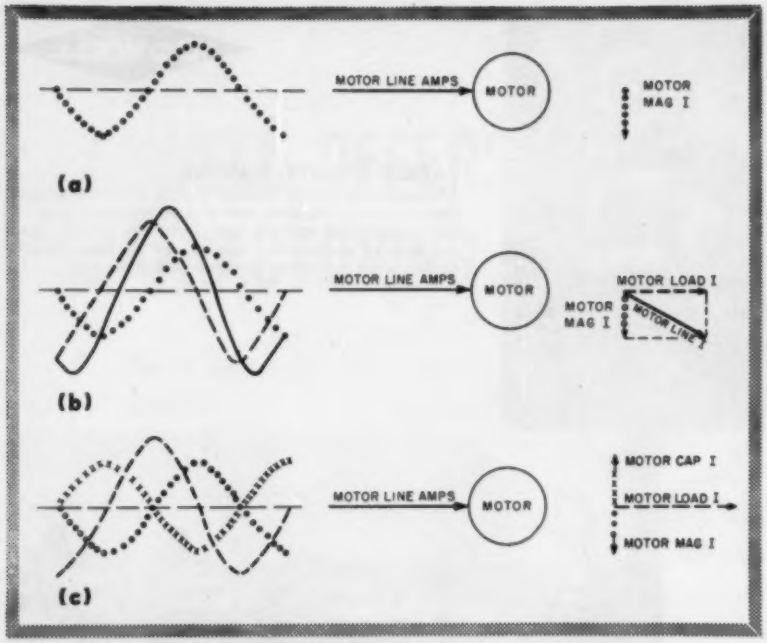

FIG. 2. **How a capacitor reduces line current:** (a) Line current drawn by motor equals motor magnetizing (inductive) current; no load current. (b) Line current drawn by motor equals vector summation of motor magnetizing (inductive) current plus motor load (resistive) current. (c) Line current drawn by motor equals load current only, since magnetizing (inductive) current and capacitor (capacitive) current cancel each other out.

inductive current. Thus, line current is effectively reduced from the capacitor back to the power source. Fig. 3 shows an oscillograph of actual line current for a 10 hp oil well pumping motor with and without capacitor.

This reduction in line current will reduce line losses and allow smaller size transformers and conductor to be used.

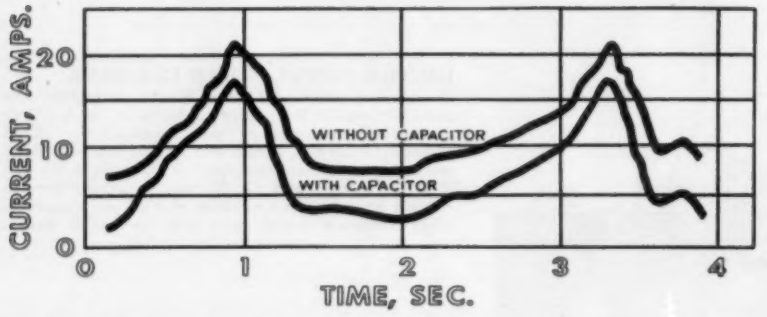

FIG. 3. **Oscillograph** of motor line current of a 10-hp beam pumping motor, showing reduction in line current with 6 KVAR capacitor installed with motor.

FIG. 4. Economic results of using power factor correction capacitors installed at pumping motors.

Field Characteristics					
Number of wells	9	7	13	9	12
Size of wells, hp	7.5	7.5	7.5	10	10-7.5 2-10
Transformer capacity, kva	45	27	45	75	75
Capacitor cost ($12.50/KVAR), $	337	70	650	450	462
V increase at farthest pump, %	7.5	4.5	11	6	6.6
Annual kwhr decrease, %	9.3	3.5	14	4	10.4
Transformer capacity released, %	56	45	94	43	53
Savings Effected, Dollars					
Annual power cost (1.3¢/kwhr)	130	63	325	120	374
Transformer capacity ($17/KVA)	425	204	730	544	680
Maintenance ($15/hp)	30	24	44	41	43
Capacitor cost repaid, 1st yr, %	37	50	50	27	81

Capacitors Reduce Losses and Power Billing

Typical electrified oil leases operating without capacitors have system power factors in the order of 35 to 50 percent. Capacitors installed at the motors can improve system overall power factor close to 90 percent. In effect, they can supply the magnetizing or excitation current requirements of the motor to which they are connected, thereby relieving both the transformer and the conductor of supplying this portion of motor current. This will considerably reduce the line current and associated I^2R heating losses of the distribution system. Actual measurements on a typical oilfield installation have shown that capacitors reduce line current drawn by the motor by a conservative 25 percent.

Thus, I^2R losses produced by that motor load are decreased by 44 percent — an amount well worth considering when it is remembered that cost of system I^2R losses alone in one year can equal as much as 15 percent of the total distribution system first cost. Whether or not a power factor clause is involved in the power contract, capacitors generally prove to be a worthwhile investment by lowering the power bill.

It should be emphasized that, in general, capacitors are a worthwhile investment whether or not a power factor penalty clause is involved in the power contract. Because of the reduction in system I^2R losses alone, capacitors will normally pay for themselves within two to four years — perhaps within six months, if a power factor clause is enforced. In addition to savings in power bills and better operating torques for the motors, capacitors often reduce considerably motor outages and maintenance costs by eliminating overloads on the motors due to low operat-

The Author

John H. Day, Jr., *is petroleum products specialist for the General Electric Company in Dallas, Texas. Day is an electrical engineer graduate of the United States Naval Academy, Annapolis, 1944. He joined GE in 1946 in Schenectady, New York, and has served in various design and commercial engineering capacities prior to coming to Dallas in 1951.*

Day is a member of the API and active in two sub-committees. He is a member of the American Institute of Electrical Engineers and is currently serving on the production subcommittee for the AIEE Petroleum Conference. He is a registered professional engineer and a member of the Texas Society of Professional Engineers.

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ing voltage. Fig. 4 shows actual field results on five different leases in West Texas. When capacitors were added to the system a very favorable return on investments resulted as well as improved operation of lease electrical system.

New System Investment

Normally, transformers are sized to the load on the basis of one KVA of transformer per horsepower of motor load, assuming full load and no diversity factor. Based on the reduction of line current by using capacitors, however, transformer sizes required can be determined on the basis of ¾ KVA per hp rating. This represents conservative practice, and with proper diversity factor and cyclic loading of the motor loads factored in, the KVA per horsepower sizing ratio can be safely figured even lower.

Similar savings in conductor size and costs can be made by the use of capacitors. A new system planned with capacitors at the motors will generally cost less than the distribution system which would be required to serve the same pumping load without capacitors. On existing leases the addition of capacitors will sometimes allow new loads to be safely added to existing transformer banks and conductor runs.

Motor Operating Torques

Voltage drop is a function of load current and power factor. By reducing the current and improving power factor, capacitors can help reduce voltage drop. By improving voltage levels capacitors can help increase the efficiency of existing systems and allow them to serve large loads without the installation of new or larger feeders and distribution transformers. They will also result in better operating torques of the oil well pumping motor. As a matter of fact, motor torque varies as the square of the applied line voltage.

If the voltage level at the motor is only 90 percent of rated nameplate voltage, the motor will develop only 81 percent of rated torque.

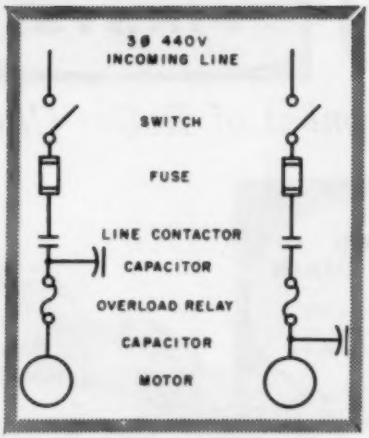

FIG. 5. Motor line circuit diagram showing alternate methods of locating capacitor. Installed ahead of overload relay (left) is preferable since it allows standard-size overload heater relay table to be used.

This is important when starting the dead weight of a high-inertia beam pumping unit which may be improperly balanced, or where high fluid viscosity may exist in the well.

On new systems, voltage drop is often one of the most important factors affecting cost. Increasing transformer and cable size is one way to reduce voltage drop, but the most economical and practical way of reducing voltage drop is power factor improvement by means of capacitors.

Description and Installation

Three-phase oilfield capacitors have been developed in a weatherproof construction for outdoor installation at the motor location. They are available in ratings designed to closely match the three-phase oilfield motor to which they are applied.

To allow maximum effectiveness and reduction in line size, capacitors should be connected as close to the motor as practicable. They are provided with 4-ft flexible leads including ground wire for connection to the motor or controller. Standard ¾-in. pipe threads are provided if conduit connection is desired.

Usual practice is to mount the capacitor on a stub pole with the motor controller close to the pumping unit, as shown in Fig. 1. Preferably, the capacitor should be connected between the line contactor and the overload relay so that the overload relay heater elements will be correctly sized to the actual motor line current. Then the size of the overload heaters will not have to be changed as they would if the capacitor were located on the load side of the overload relay.

This arrangement will provide a disconnect means and will allow the capacitor to be switched with the motor to give the right amount of power factor correction when the inductive motor load requires it. The methods of locating the capacitor are shown in Fig. 5.

Selection of Capacitors

When capacitors are connected on the load side of the motor controller, it is important to properly size the capacitor to the motor to prevent possible over-voltage from motor self-excitation or perhaps cause excessive transient torques on the motor. The table (Fig. 6) is a useful guide to the maximum KVAR of capacitors to be switched with motors in oilfield pumping service.

Effects of Capacitors

When installed at the motor to be switched with the motor, capacitors will have the following desirable effects:

1. A direct savings in power cost, particularly if a power factor adjustment clause is involved and enforced.
2. A 25 percent reduction in the size of the distribution transformers and secondary conductor required to serve the various motor loads when designing a new lease distribution system, or a release of similar transformer and conductor capacity for additional load on an existing system.
3. An approximate 25 percent reduction in secondary voltage drop, resulting in better voltage levels, and, therefore, better starting torques and operating characteristics of the oil well pumping motors.
4. A 44 percent reduction in secondary system power losses.

FIG. 6. Typical recommended maximum kilovar rating of capacitors to be switched with new models of oilfield motors.

Hp Rating 1200 rpm Open, Drip-Proof, Oil Field Motor	High-starting torque, low-starting current NEMA design C motors		High-starting torque, low-starting current, NEMA design D motors	
	Capacitor KVAR	Line current Reduction (Fall Load)	Capacitor KVAR	Percent line current Reduction (Fall Load)
5	3	25½	3	14½
7½	5	25½	4	20½
10	5	13½	4	12½
15	6	17½	6	14
20	8	17	10	20½
25	10	15	10	14½
30	10	16	10	14½
40	10	13½	10	9
50	10	10½	10	7½
60	10	9	15	9½
75	15	10½	15	8½
100	30	13	—	—

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1. "Economic Design of 440-Volt Lease Distribution Systems" by Glenn W. Webb, General Electric Company, Dallas, Texas, *The Petroleum Engineer*, August 1955.
2. "Capacitors Pay Off in Electrical Beam Pumping" by Roger K. Owen, Southwestern Public Service Company, Amarillo, Texas, *The Petroleum Engineer*, January 1956.
3. "Why the Trend Toward Electrified Leases?" by J. H. Day, Jr., General Electric Company, Dallas, Texas, *World Oil*, December 1956.

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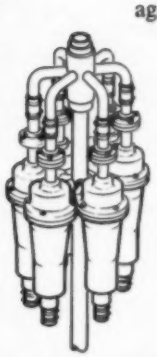

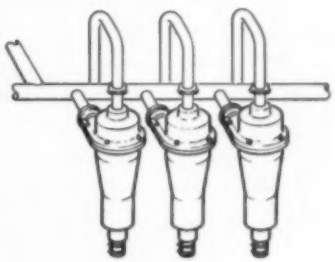

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NEUTRON LOGGING OF FLOWING WELLS

. . . detects gas caps and high GOR zones

Advanced technique solving Creole Petroleum's high gas-oil ratio problem in eastern Venezuela

Russell G. Norelius
Petro-Tech Service C. A.
Caracas, Venezuela

DEVELOPMENT of the flowing neutron log is the direct result of the need for more reliable information on gas cap locations in wells where a high gas-oil ratio is affecting production. When a well is shut in and/or killed, fluid very often invades a gas sand to a depth of several inches. If a gas sand is deeply invaded by well fluids, conventional neutron logging techniques often fail to locate the gas cap. On the other hand, the location of gas by mechanical means is costly and time consuming.

Locating points of gas entry in flowing wells by means of a neutron log is a comparatively recent development which was first tried by B. H. Bryant, H. L. Bailey of Creole Petroleum Corporation and N. L. Powell of Petro-Tech Service C. A. From the beginning the method has been successful. Field tests indicate that a properly run and properly interpreted flowing neutron log can locate points of gas entry in a flowing well nearly 100 percent of the time. It is unusual for any logging method to approach this efficiency. Fig. 1 shows a typical example of a flowing neutron log.

Interpretative methods of flowing neutron logs are different from standard radioactive logs and require special considerations. A neutron-neutron type detector detects slow or thermal neutrons. Neutrons emitted from the source are fast neutrons. As fast neutrons travel toward the detector, they are slowed to thermal velocities by a series of glancing and head-on collisions with other atoms. A neutron has about the same mass as a hydrogen atom, thus hydrogen atoms will slow fast neutrons to thermal velocities more rapidly than any other material. Other materials have some effect, but the predominant factor in determining neutron curve amplitude is the amount of hydrogen within the bore hole and formations.

The presence or absence of hydrogen governs the response of the neu-

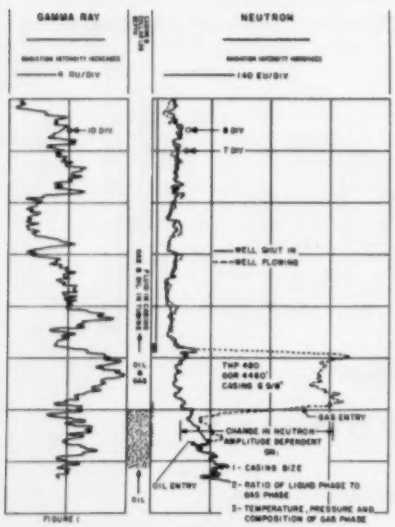

FIGURE 1

FIG. 1. Typical flowing neutron log indicates differences in curves of the well while shutin and while flowing.

H Atoms per Cubic Foot of the Paraffin Series of Oils.

		Density	Molecular weight	H atoms per cu ft x 10^{26}
Methane	CH_4	.0007168	16.04	.0303
Ethane	C_2H_6	.00135	30.07	.046
Propane	C_3H_8	.583	45.0	17.6
Butane	C_4H_{10}	—	58.12	—
Pentane	C_5H_{12}	.626	72.15	17.7
Hexane	C_6H_{14}	.660	86.17	18.2
Heptane	C_7H_{16}	.684	100.20	18.6
Octane	C_8H_{18}	.7036	114.23	18.9
Nonane	C_9H_{20}	.718	128.25	19.1
Decane	$C_{10}H_{22}$	.730	142.28	19.2
Hendecane	$C_{11}H_{24}$	.741	156.3	19.4
Dodecane	$C_{12}H_{26}$	.75	170.3	19.5
Tridecane	$C_{13}H_{28}$	.757	184.36	19.6
Hexadecane	$C_{16}H_{34}$	.775	226.44	19.9
Heneicosane	$C_{21}H_{44}$	.778	296.57	19.7
Heptacosane	$C_{27}H_{56}$	.780	380.72	19.6
Triacontane	$C_{30}H_{62}$	.7797	422.8	19.2
Water	H_2O	1.0	18.0	19.0

FIG. 2. Quantity of hydrogen in formation fluids governs the response of the neutron detector. For this reason the amount of hydrogen in the fluids is important. Here is a list of the paraffin series of oils showing H atoms per cubic foot.

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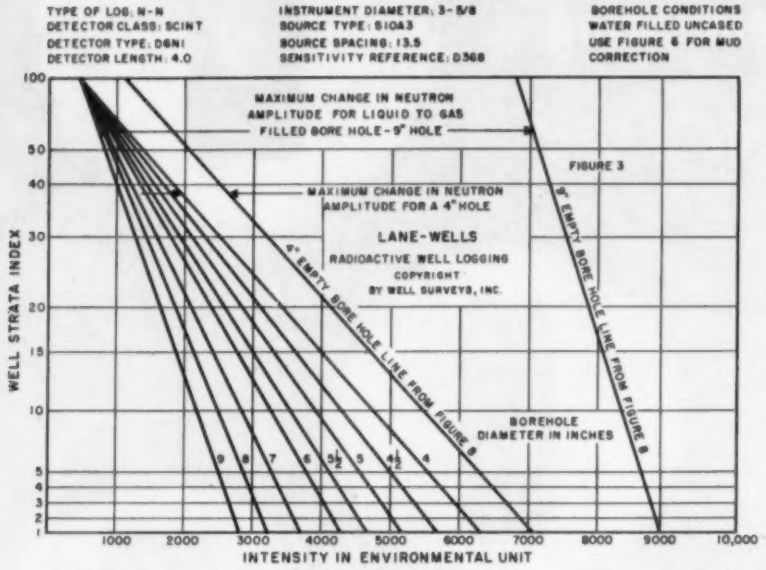
tron detector and consequently the quantity of hydrogen in formation fluids and the bore hole is of importance. Fig. 2 shows that the hydrogen atoms for water and for the paraffin series of oils are very close to 19×10^{28} hydrogen atoms per cubic foot. A similar calculation for other series of oils such as the olefins, naphthenes and so forth show these oils also have about the same number of hydrogen atoms per cubic foot as does water and slightly fewer than the paraffin series of oils. The heavier oils, such as the aromatics, have a hydrogen content approximately one-third less than that of water.


TYPE OF LOG: N-N
DETECTOR CLASS: SCINT
DETECTOR TYPE: DGNI
DETECTOR LENGTH: 4.0
INSTRUMENT DIAMETER: 3-5/8
SOURCE TYPE: SIOA3
SOURCE SPACING: 13.5
SENSITIVITY REFERENCE: D368
BOREHOLE CONDITIONS
WATER FILLED UNCASED
USE FIGURE 6 FOR MUD CORRECTION
MAXIMUM CHANGE IN NEUTRON AMPLITUDE FOR LIQUID TO GAS FILLED BORE HOLE - 9" HOLE
FIGURE 3
MAXIMUM CHANGE IN NEUTRON AMPLITUDE FOR A 4" HOLE
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9" EMPTY BORE HOLE LINE FROM FIGURE 8
9" EMPTY BORE HOLE LINE FROM FIGURE 8
BOREHOLE DIAMETER IN INCHES
9 8 7 6 5½ 5 4½ 4
WELL STRATA INDEX
100 50 40 30 20 15 10 5 4 3 2 1
1000 2000 3000 4000 5000 6000 7000 8000 9000 10,000
INTENSITY IN ENVIRONMENTAL UNIT

FIG. 3. **The 4-in. and 9-in. empty bore** hole lines, illustrate maximum possible change in neutron amplitude will be great in large diameter holes and relatively small in small diameter holes.

Since most oil mixtures have a hydrogen content about equal to water, the bore hole can be filled with either oil or water and the curves shown in Fig. 7 will give the neutron amplitude for sands of various porosities. The sands can be filled with oil (the heavier oils excepted) or water with no appreciable effect on neutron amplitude.

A mud is a mixture of water and solid particles. The solid particles displace some water. A mud, therefore, has less hydrogen atoms per unit volume than water. In general, the heavier the mud the lower the hydrogen content. Reducing the hydrogen content of the fluid in the bore hole will cause the neutron curves shown in Fig. 7 to shift to the right. Fig. 6 shows correction factors for some mud weights. After the correction is made for mud weight the well strata index will again read directly as porosity.

Fig. 7 shows the response of the neutron curve opposite liquid filled porous sands. The neutron curve obeys the same law as in liquid filled sands when opposite non-invaded gas sands. As an example, assume a 30 percent porosity sand whose pore space is filled with 70 percent gas and 30 percent residual water. In this example, the gas is assumed to have zero hydrogen content

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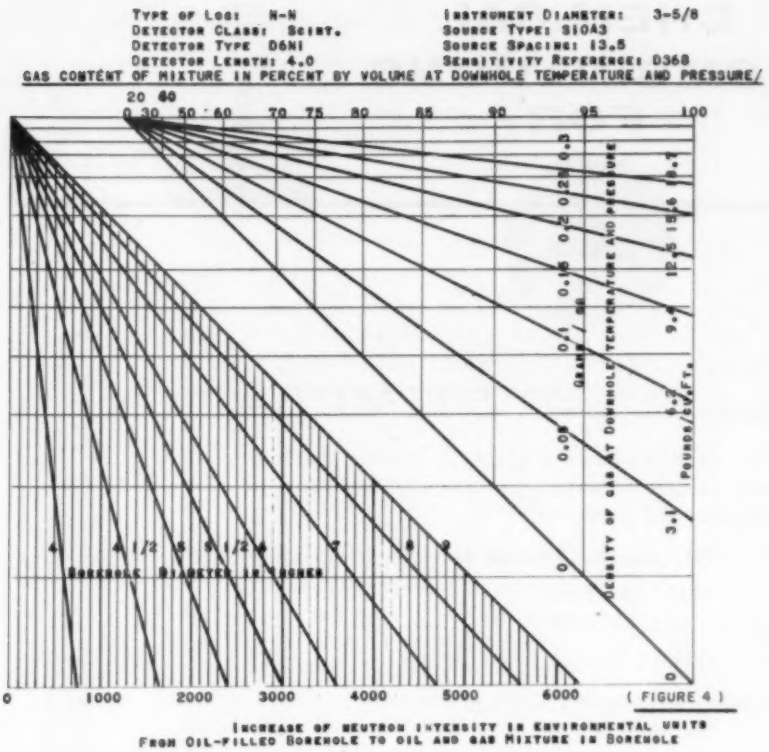

FIG. 4. **Gas content,** in percent by volume, may be estimated by the use of this nomograph.

and the response of the curve is the same as a 9 percent (.3 x .3) liquid filled sand. The sand can be interpreted as gas because of the greater than normal neutron amplitude.

Most gas sands are invaded by drilling fluids, which increase the amount of hydrogen surrounding the detector. Fig. 7 shows that as bore hole diameters increase, the neutron curve amplitude decreases. A one inch increase in bore hole diameter adds a one inch cylinder of fluid to the hydrogen surrounding the instrument. One inch of invasion in a gas sand, adds a one inch cylinder, times the porosity fraction of the sand, to the liquid surrounding the instrument. Thus, each additional one inch of invasion will reduce the neutron amplitude, but by a lesser amount than does a one inch increase in hole diameter.

At an invasion depth, just equal to the deepest depth of penetration of neutron affecting the measurements, the curve response for an invaded gas sand will be the same as a liquid filled sand. Thus, in the example of a 30 percent porosity gas sand between the points of no invasion to critical invasion, the neutron amplitude will decrease from an amplitude equivalent to a 9 percent porosity sand down to the amplitude of a 30 percent porosity sand. In conventional neutron logging, gas sands are

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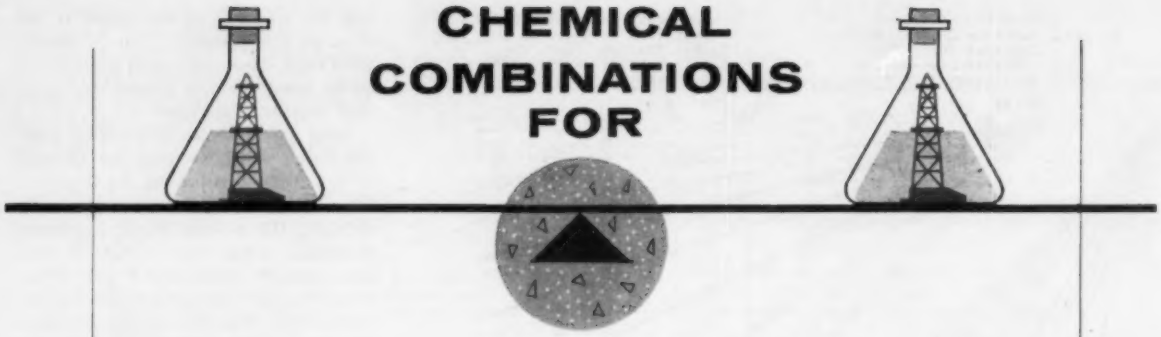

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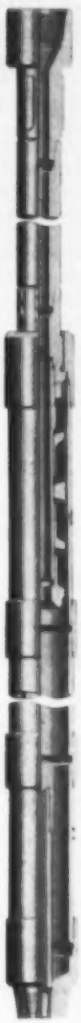

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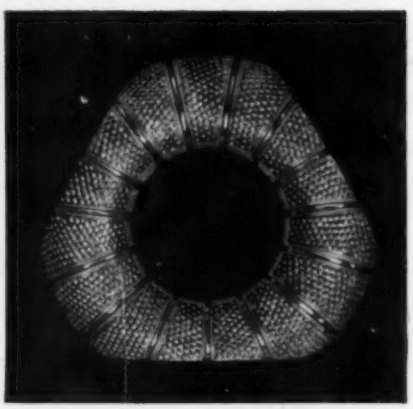

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detected when the gas is present near the well bore and will be recorded as a greater than normal neutron amplitude opposite the gas sands.

A flowing neutron log locates the point of gas entry because of gas within the well bore and not because of the presence of gas in the sand. When the neutron instrument moves from a liquid into an admixture of oil and gas in the bore hole, its response is a large shift to the right of the neutron curve. The total change in log amplitude between a flowing well and a well shutin is dependent on:

1. Casing size,
2. Ratio by volume of liquid phase to gas phase,
3. Temperature, pressure and composition of gas phase.

The change in neutron amplitude is primarily dependent on the casing size and the ratio of liquid phase to gas phase. Temperature, pressure and composition of gas phase has a lesser effect.

Fig. 7 and 8 show the response of the neutron curve versus bore hole diameter. In the illustration* a 3⅜ in. neutron-neutron detector was used, whereas in a flowing neutron log a 1¾ in. neutron-neutron detector was used. In Fig. 7 and 8 the effect of a smaller instrument would be to increase the stated bore hole diameters slightly. Intensity in environmental units** (EU) would also differ for a 1¾ in. neutron instrument. In a relative sense, Fig. 7 and 8 can be used to illustrate the effect of casing size on change in neutron log response at points of gas entry. Fig. 7 shows the neutron response for a liquid-filled bore hole. Fig. 8 shows neutron response for an empty bore hole (which can be considered the same as a gas-filled bore hole).

Thus, the idea of the neutron curve moving to the right as the hydrogen content in the bore hole is reduced can be carried to the extreme case of an empty bore hole. One can then consider the curves of Fig. 7 (water-filled bore hole) moved to the positions shown in Fig. 8 (empty bore hole).

In Fig. 3 the 4-in. and 9-in. empty bore hole lines have been superimposed onto Fig. 7. This shows very clearly that the maximum possible change in neutron amplitude will be very great for large diameter holes and relatively small for small diameter holes. The change in neutron amplitude will always be less for a producing well. Where gas is entering the bore hole an admixture of oil and gas will be formed. The reduced hydrogen content of the mixture will cause the neutron curve to shift to the right by an amount dependent on the subsurface ratio of the gas phase to oil phase.

Fig. 4 shows a method of estimating the subsurface ratio of gas to oil. The chart is used as follows:

Read the difference in neutron curve intensity at a given depth between the run made with gas entering and the run made with 100 percent liquid in the hole. Enter the chart along the bottom edge at the corresponding value in EUs. Follow vertically upward to the diameter line corresponding to the size of the bore hole at the given depth. (Note: If the gas-liquid mixture is confined in a liner use the inside diameter of this liner.) From the intersection formed, follow horizontally to the line corresponding to the gas density under

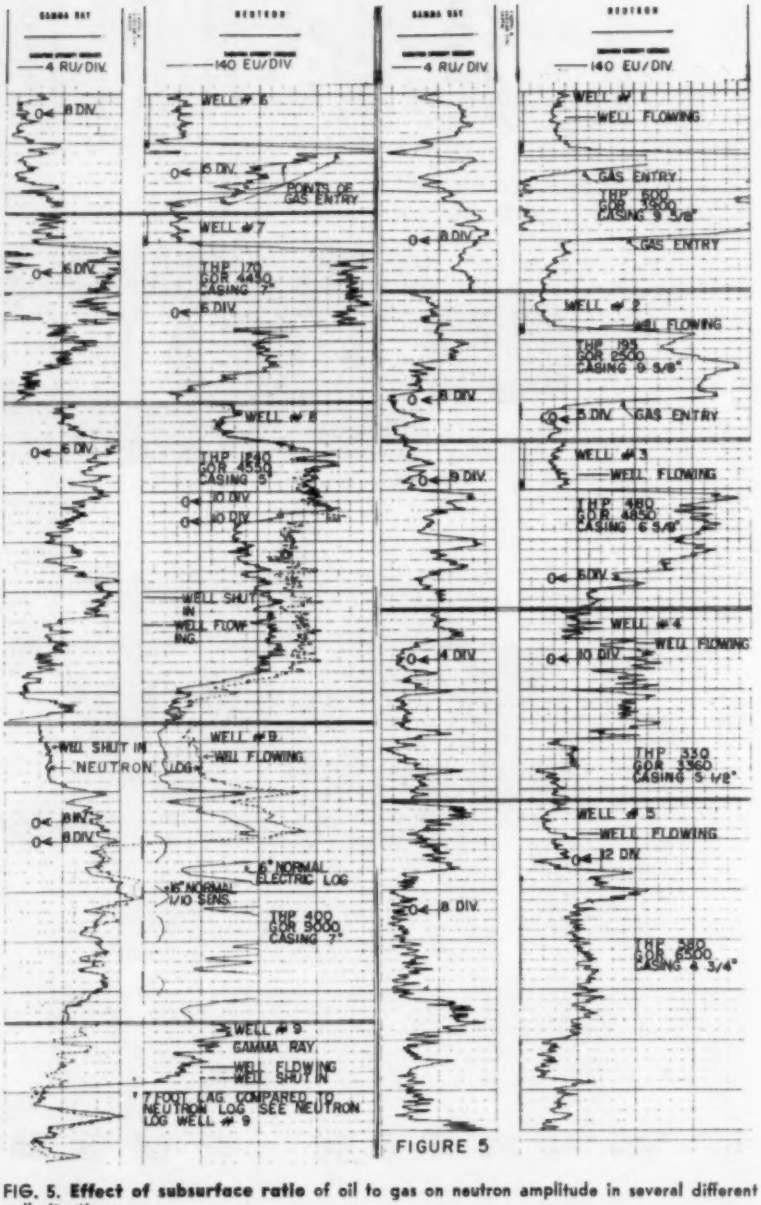

FIGURE 5

FIG. 5. **Effect of subsurface ratio** of oil to gas on neutron amplitude in several different well situations.

*"Well Strata Index." This property responds closely to liquid-filled porosity in pure calcium carbonate or other similarly non-hydrogenous rock matrix materials. The well strata index may be regarded as a measure of the sum of the removable liquids plus any additional constituents which similarly affect the neutron curve. These latter include water of crystallization, bound water, and hydroxyl components; common constituents of the clay minerals.

**The intensity scales (along the bottom edge of the charts) are graduated in environmental units, based upon use of the type D368 environmental calibrator. This calibrator, which may be used with any of the various neutron logging instruments, produces a response which, for any given instrument and source-spacing, is defined as 1000 environmental units (1000 EU). Thus a log deflection equal to that produced by the D368 calibrator represents an intensity of 1000 EU. Logs which have been so calibrated are distinguished by the designation "D368" in the heading, opposite the words "sensitivity reference."

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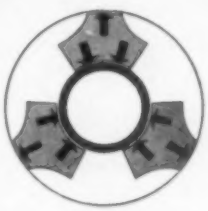

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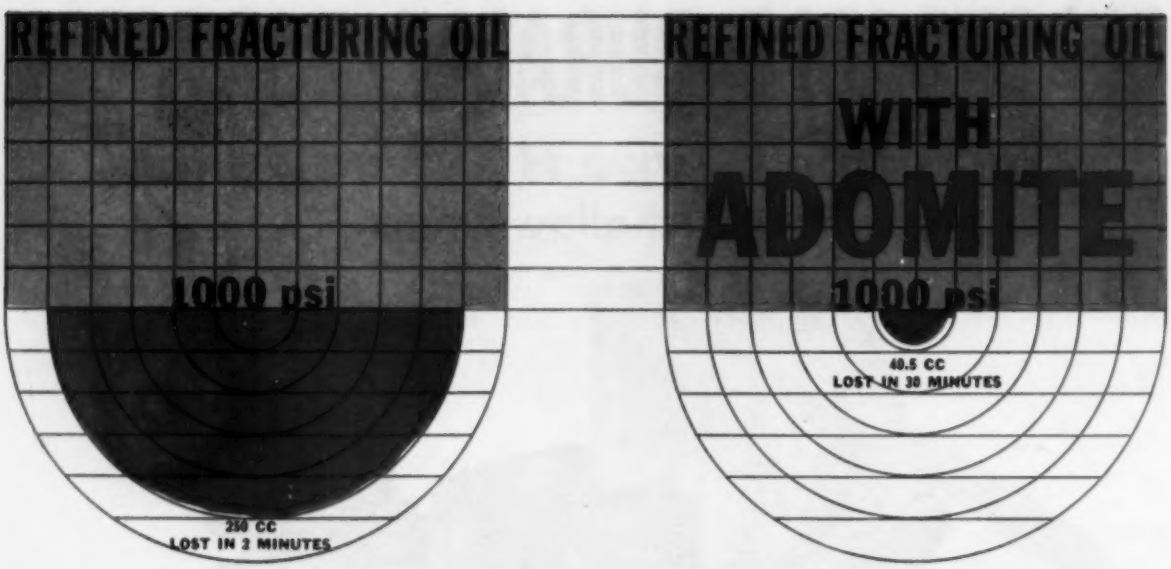

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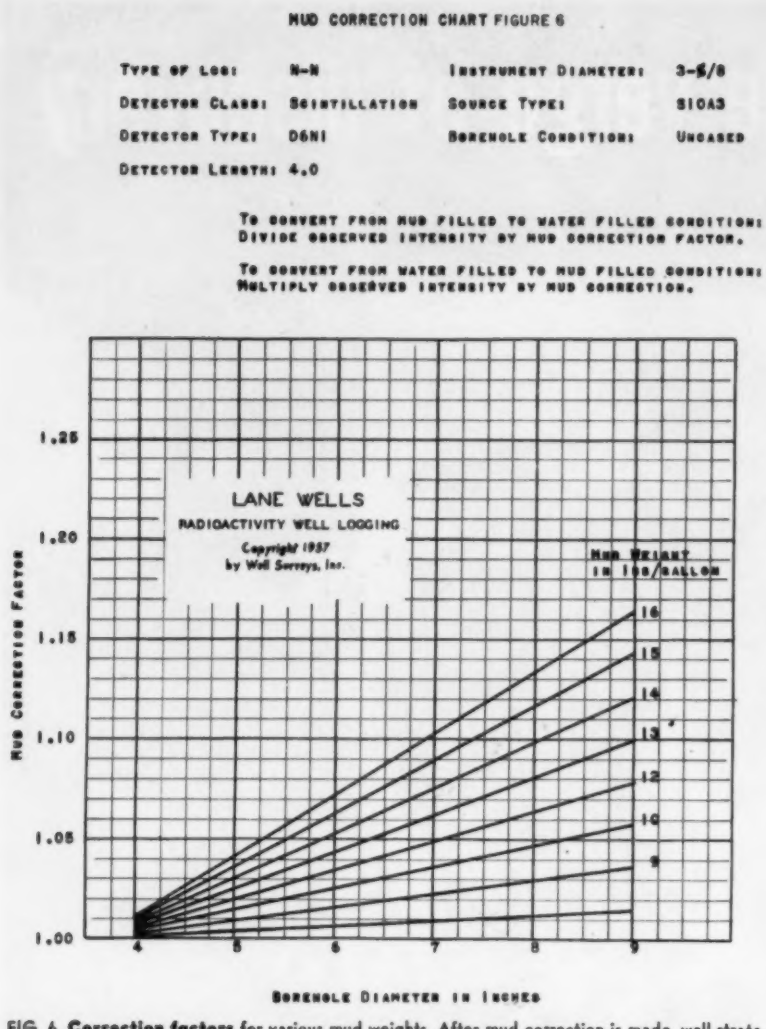

FIG. 6. **Correction factors** for various mud weights. After mud correction is made, well strata index will read directly as porosity.

the temperature and pressure prevailing at that depth. From this point follow vertically upward and read the gas content in percent by volume from the scale along the top of the chart.

The effect of subsurface ratio of oil to gas on neutron amplitude is shown in Fig. 5. The lower neutron amplitude of Well 2 compared to Well 1 is because of the lower gas-oil ratio of Well 2. Well 5 shows the effect of smaller casing sizes. This effect can be seen by comparing Wells 2 through 5.

Note that the 4-in. empty and liquid-filled bore hole lines are parallel. The two 9-in. lines are nearly parallel. For all practical purposes, within the porosity ranges normally encountered in a bore hole, the empty and liquid-filled bore hole lines for all diameters can be considered to be parallel. As an example, a 9-in. liquid-filled bore hole shows a change of 1170 EU for a change of porosity of 40 percent to 10 percent. In comparison, the 9-in. empty hole line shows a change of 1050 EU for a porosity of change from 40 percent to 10 percent. The maximum possible error in considering the lines parallel is less than 10 percent.

The concept of the liquid-filled to partially liquid-filled bore hole lines being parallel when interpreting flowing neutron logs is important. This means that the separation between a shutin log and a flowing log will be constant irrespective of neutron amplitude, as long as there is no additional entry of gas or oil. Well 8, Fig. 5, shows a practical example wherein the separation between the shutin log and flowing log is constant irrespective of neutron amplitude. The fact that the separation is constant is of particular importance in the case of an oil well with a point of oil entry above a point of gas entry. At the point of oil entry, the amount of separation would be reduced and the fact that oil was entering the well could be interpreted.

There is one exception to the rule of a constant separation between a shutin log and a flowing log and that is the case of a perforated gas sand. Under shutin conditions well fluid can, and frequently does invade the gas sand rather deeply so that a shutin log shows the gas sand essentially as a fluid sand. Under flowing condition, the invaded zone fluids flow back into the well. Under flowing conditions there is an increase in neutron amplitude because of gas within the well bore. Opposite gas sands there is an additional amplitude because of gas in the sand external to the pipe.* Well 9 on Chart No. 5 is an example of this effect. The 16-in. normal resistivity curve shows the gas sand to be 50 ft thick. If one subtracts the shutin log from the flowing log, there will be a greater separation opposite the 50 ft gas interval than opposite the shale section just above.

Fig. 9 shows a different method of locating the point of gas entry in a flowing well. Gas and oil frequently flow up the tubing by heads. Usually, the admixture of oil and gas near the point

The Author

Russell G. Norelius *is chief logging engineer for Petro-Tech Service C. A. An electrical engineering graduate of the University of Minnesota, he joined Lane-Wells in 1938. After World War II, Norelius advanced to division logging engineer and later to district superintendent for the parent company. He has served as chief logging engineer for Petro-Tech in Caracas, Venezuela, since 1952.*

*Opposite unperforated gas sand intervals this effect will not be seen. Since the pipe is not perforated the conditions external to the pipe are the same for both the shut in and flowing logs. The separation between the curves will be the same opposite the gas sand just as for other types of formations.

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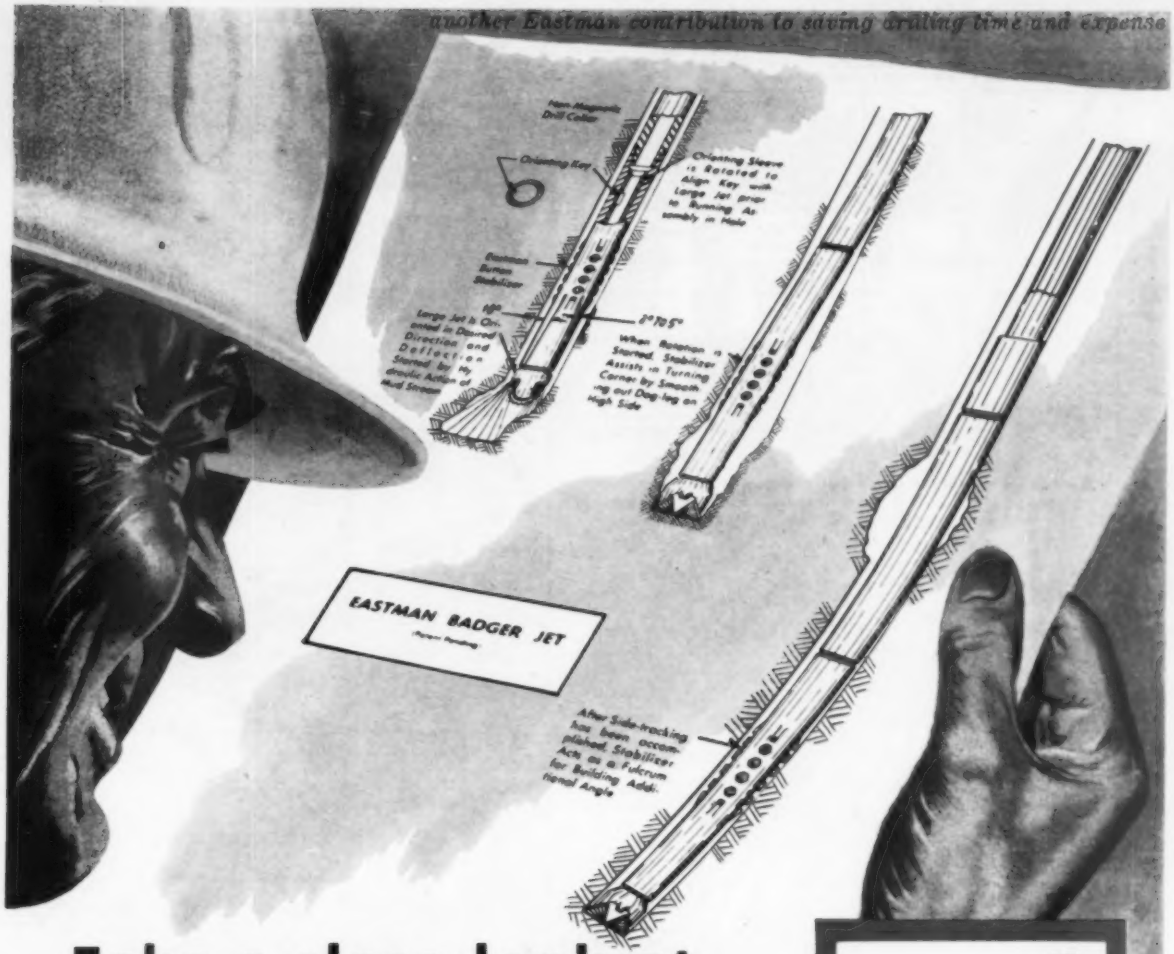

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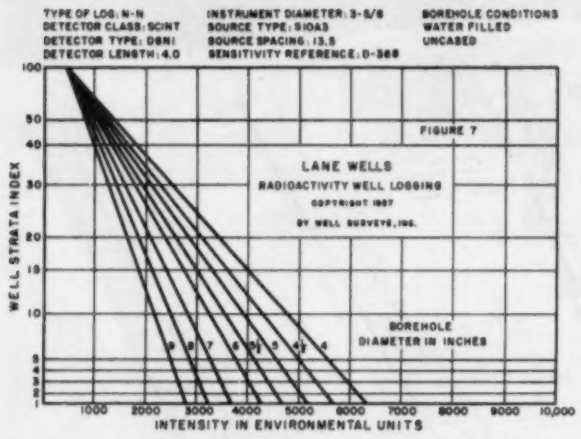

FIG. 7. **Curves show neutron amplitude** for sands of various porosities in water-filled uncased hole. By reducing the hydrogen content of the fluid in the bore hole, the neutron curves will shift to the right.

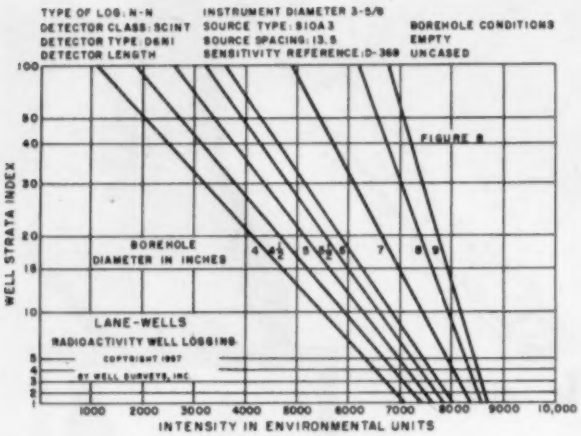

FIG. 8. **Chart shows neutron response** for an empty bore hole. This may be considered the same as a gas-filled hole.

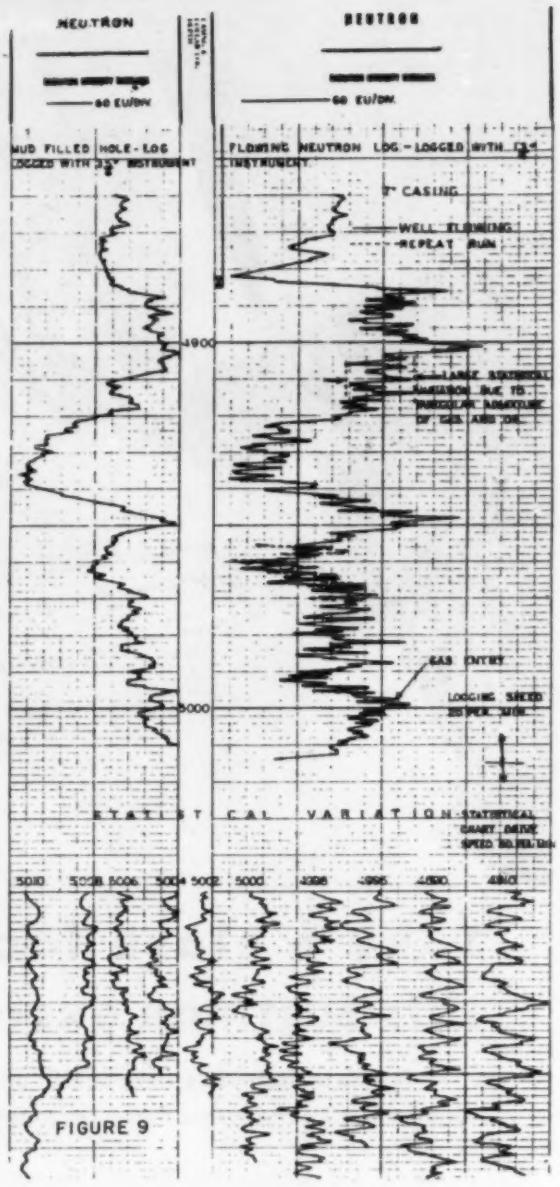

FIG. 9. **A different method for** locating the point of gas entry in a flowing well. In this illustration, the well is flowing by heads. This is noted as a deflection to the right during the time gas bubbles are opposite the neutron detector; when fluid is opposite the detector, there will be a deflection to the left.

of gas entry is fairly uniform. This is shown in Fig. 5 by the smoothness of the neutron curve above and below the points of gas entry.

Fig. 9 shows an example where the gas is entering the well bore by heads. When gas is entering the well bore by heads, there will be a deflection to the right during the time gas bubbles are opposite the neutron detector. When fluid is opposite the detector there will be a deflection to the left.

The bottom of Fig. 9 shows a series of statistical readings taken at various depths. These were taken with the instrument standing still for a period of about three minutes. The reading shown at 5010 ft is about the normal variation one expects for this instrument at a sensitivity of 60 EU per Div. The statistical remains about the same at 5008 ft and 5006 ft. Starting at 5004 ft there is a gradual increase in apparent statistical up to about 4995 ft, following which there is no increase in apparent statistical. This apparent increase in statistical is because of gas entering the well bore by heads and definitely pin points the point of gas entry.

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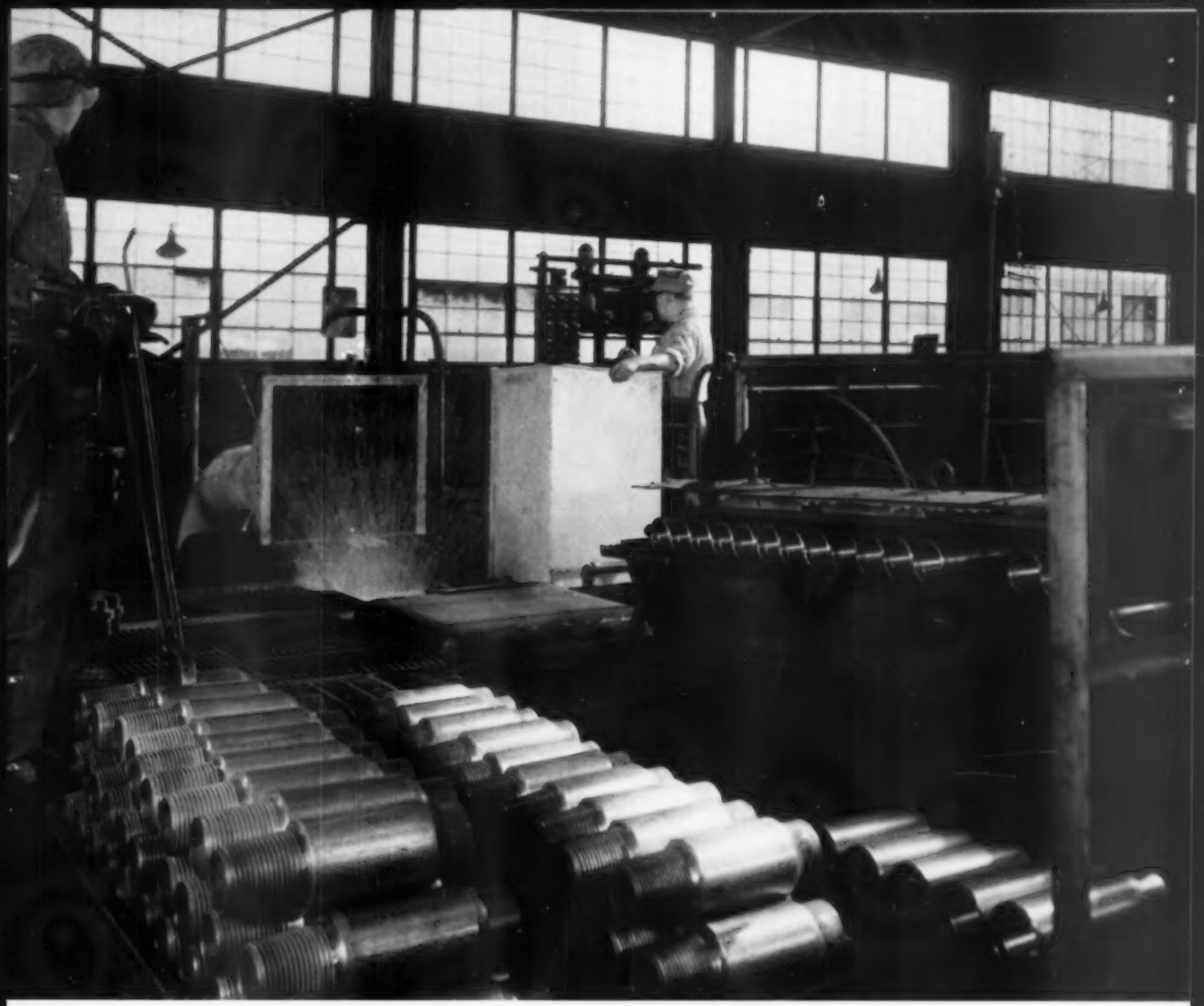
4. Kill the well.
5. Re-run the log. ★ ★ ★



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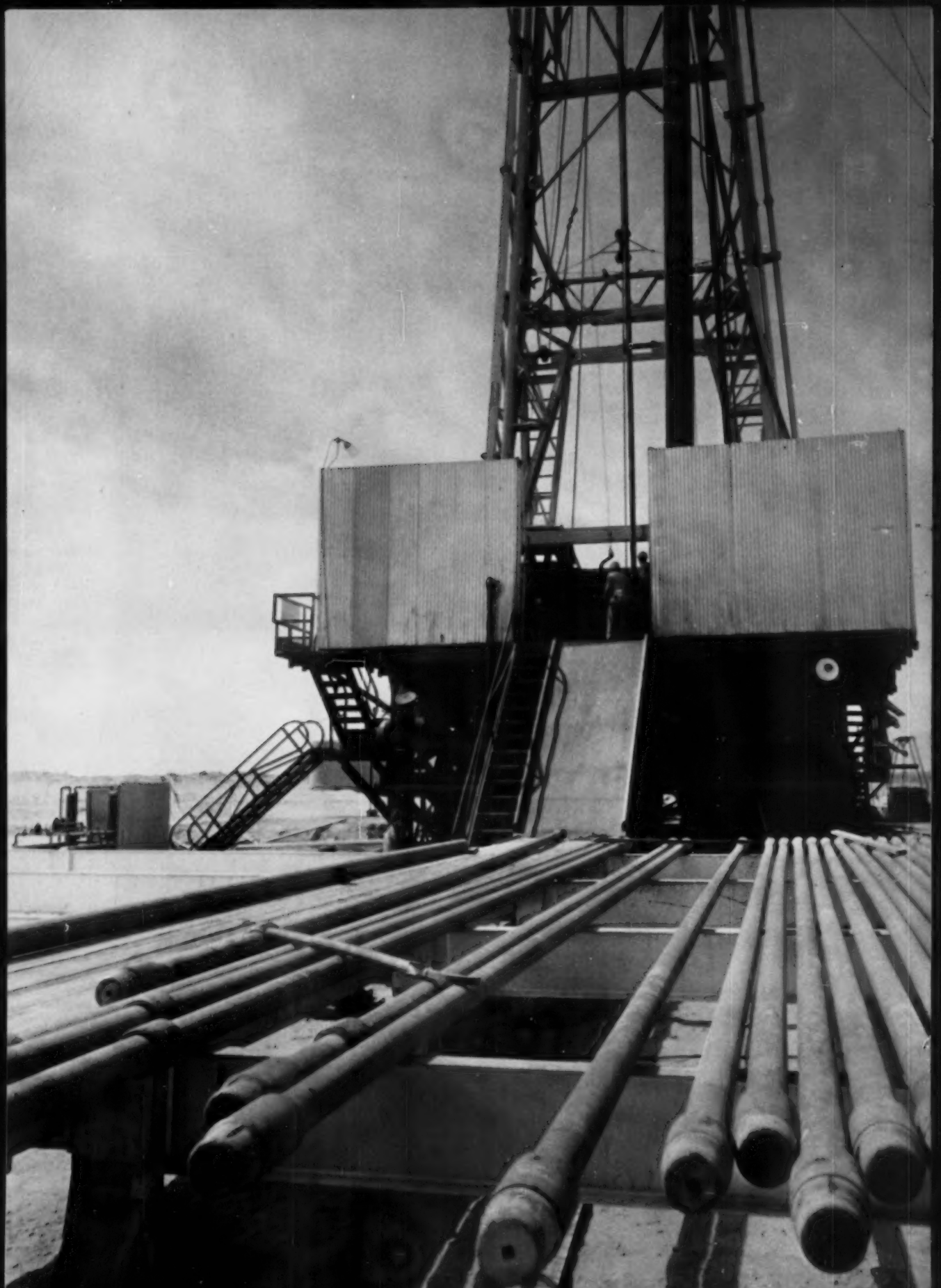

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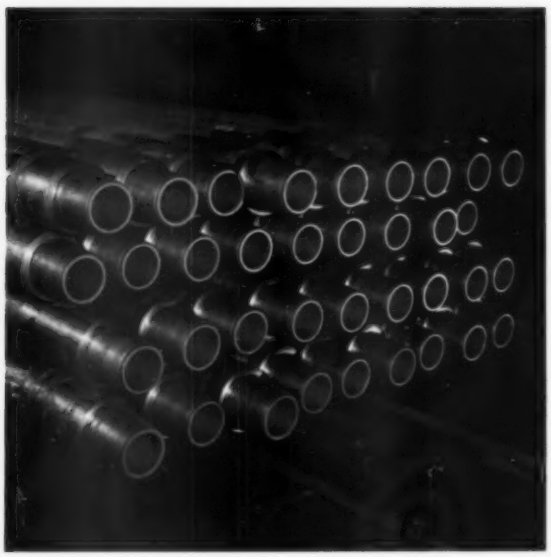

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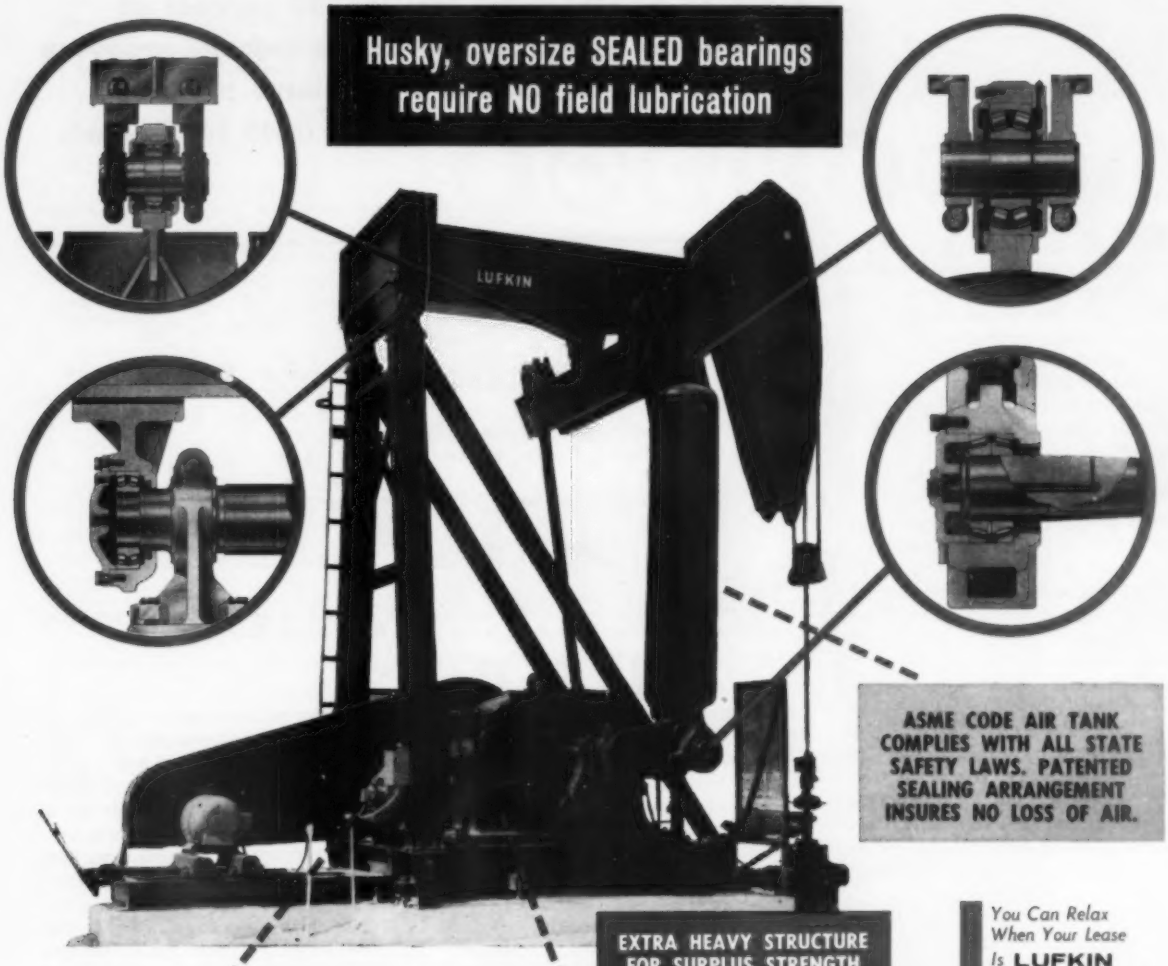

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Fire-Flood Experiment Proves Higher Recovery

Eighteen months after ignition, 50 percent of oil in place was produced in this thermal recovery test. Normal production would have produced 10 to 15 percent of oil in place in 40 to 60 years

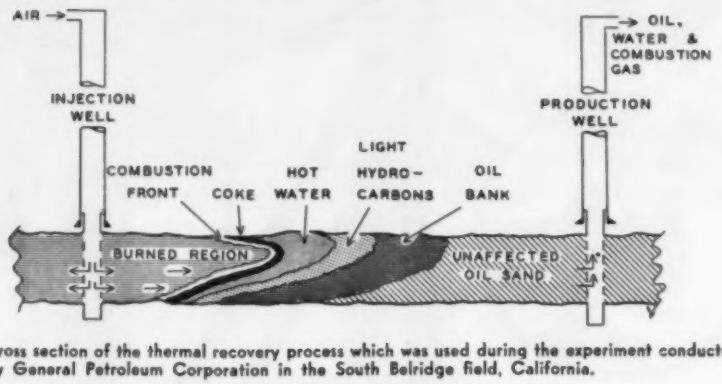
IT COSTS a lot of money to get previously unrecoverable crude oil out of the ground by passing a combustion front through the oil zone . . . but such oil can be recovered successfully. These two counterbalancing facts were the highlights of the three-year thermal recovery experiment conducted in California by General Petroleum Corporation.

General Petroleum was the operator for the more than $1,000,000 research project conducted in Kern County's South Belridge field about 30 miles north of Taft.

Other companies contributing to the project were: Continental Oil Company, Chanslor-Western Oil and Development Company, Esso Research and Engineering Company, Gulf Oil Corporation, Honolulu Oil Corporation, Ohio Oil Company, Shell Development Company, Sunray Mid-Continent Oil Company, The Texas Company, Tidewater Oil Company, and Union Oil Company. The method used was based on pioneer laboratory and field work by the Magnolia Petroleum Company.

One of the spectacular results of the experiment was that the total oil rate of the four production wells reached a level some 15 times their total rate before ignition, for a while. Within the one and one-half years after ignition, about 50 percent of the oil initially in place was produced. With normal methods of production a recovery of 10 to 15 percent of the oil in place could be expected in the life of the field, 40 to 60 years.

However, high rates of burnt gases and corrosive conditions in hot producing wells created extremely severe bottom-hole well maintenance problems and led to serious bottom-hole well failures. Such failures were limited to the immediate area of the project in which active combustion was taking place.



Cross section of the thermal recovery process which was used during the experiment conducted by General Petroleum Corporation in the South Belridge field, California.

Overall cost of the experiment was several times the value of the oil produced but was considerably higher than might be expected in a possible commercial application of the process. The higher costs included the drilling of four observation wells and three core holes and many measurements made in the interests of research.

Also, the test pattern area was only half the normal five-acre well spacing in this field. The 2½-acre test pattern included four equally spaced production wells surrounding one centrally located injection well.

Greatest items of cost were drilling, repairing, redrilling, abandoning and replacing producing wells, and the cost of the three air compressors and their operation. Other factors which made the cost so high included surface and subsurface maintenance, technical labor, buildings, instrumentation and various measuring and gaging devices.

The experiment started May 31, 1955, with the purpose of obtaining basic information needed for making engineering and economic appraisals of commercial recovery of heavy oil by this thermal recovery method. Since combustion recovery experiments in other areas had been conducted in smaller patterns, an important purpose of this test was to determine whether the process could be operated in a pattern of near-commercial well spacing.

South Belridge was chosen because its oil sands are similar to many heavy oil sands which typically have low primary recovery and leave a large amount of oil in place. Such fields are not particularly suited for common secondary recovery methods.

From a conservation viewpoint, only a small fraction of the otherwise unrecoverable crude oil is consumed as fuel in the process. The bulk of the fuel is coke and heavy residuum, the least valuable part of the oil. The lighter, usable oil is pushed ahead of the burning front after its viscosity has been reduced both by temperature and removal of the heavy ends.

The experimental area looked like

Aerial view (right) shows the South Belridge thermal recovery project. Injection well with derrick is surrounded by four producing wells.

any other oil field—above the ground—while the test was being conducted. There were some highly sensitive instruments recording significant events, but to the casual observer, this was "just another oil field." The big changes were going on under ground at a depth of 700 ft in a 30-ft interval of Tulare sand.

Detailed planning and drilling of wells was followed by pumping of the wells from October 1955 through February 1956. Air injection was started March 1, 1956, and continued with only brief interruption through to the end of the experiment. The total oil rate was 20 bbl per day before ignition. The compressors had a rated capacity of 3.5 million cu ft per day at a maximum pressure of 500 psi.

Air was injected at a temperature of about 100 F. Despite the low injection temperature, heat generated by slow oxidation of oil in the reservoir gradually raised the reservoir temperature. The oil ignited spontaneously at the injection well on June 15, 1956. Ignition equipment was never used.

Although air injection had little direct effect upon liquid production, oil rates began to increase rapidly about two weeks after ignition took place. Frequent well stimulation work was necessary to maintain oil rates. As the combustion front approached production wells, the water cut increased and water and oil emulsions became a serious problem.

The combustion front reached two of the producers about three months after ignition, but corrosive conditions and high temperatures downhole made well maintenance difficult and costly. To continue production it was necessary to drill replacement wells. Stainless steel liners were installed in the replacement wells and gave much better service than the conventional steel liners of the original wells.

As a result of well failures and recompletions or replacements, and well stimulation work, oil rates were erratic. After failure of the two wells, the total oil rate fell to its lowest level of 20 bbl per day. Upon completion of replacement wells, the oil rate reached its maximum level of 300 bbl per day for a short while.

This test demonstrated that much of the Belridge heavy oil which was previously impossible to bring to the surface can be recovered rapidly—but at a high cost. ★ ★ ★

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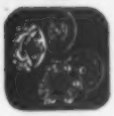
Insure longer work life and reduce down-time with this NEW extra heavy-duty ROCKFORD POWER TAKE-OFF.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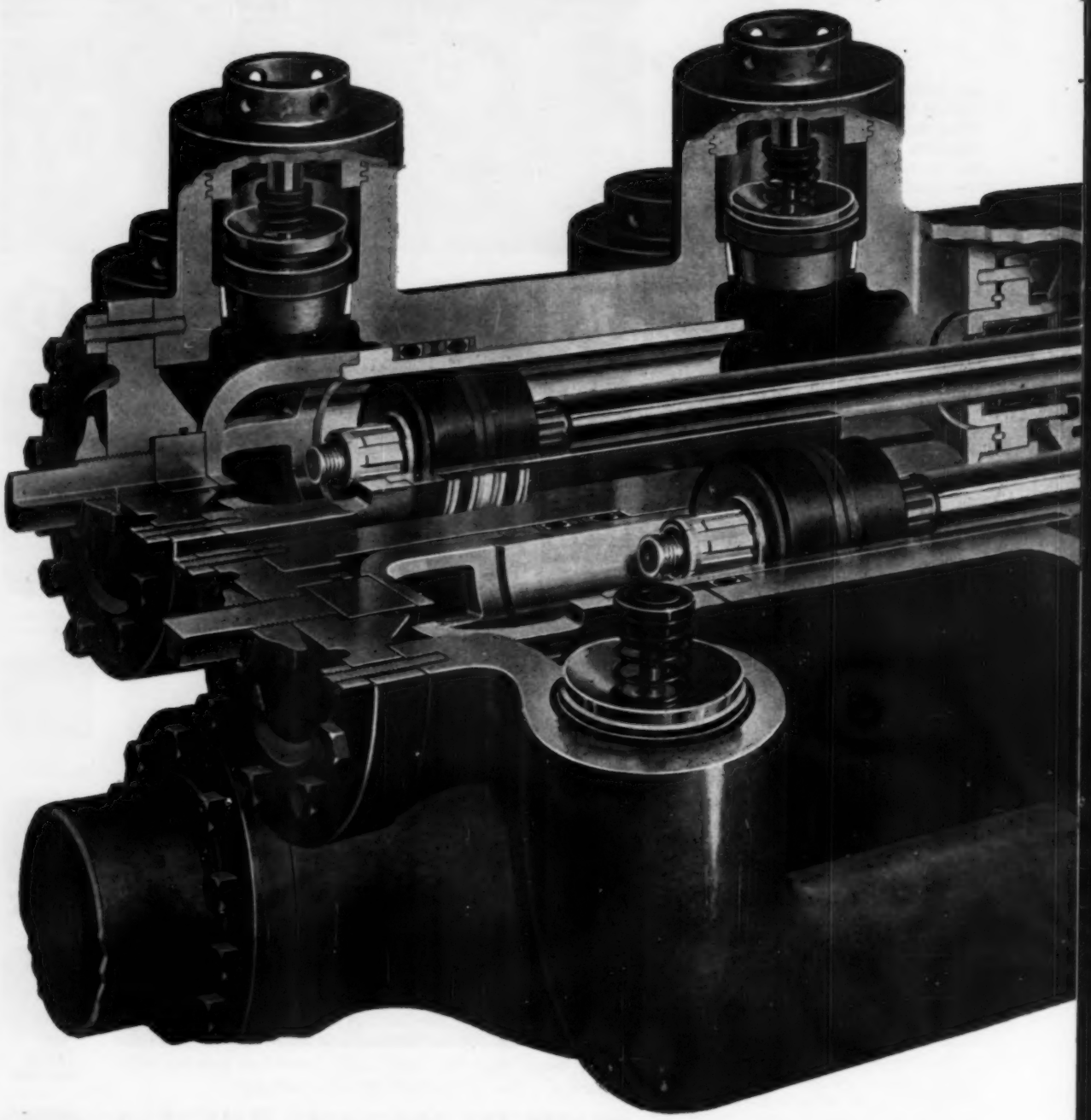

Since fluid-end pump parts must be correctly maintained for longest service, Mission has prepared a special Pump Maintenance Manual for your benefit. Write for your copy today!

PISTONS • PISTON RODS • SLIPS • GLAND PACKINGS • LINERS • LINER PACKING
PUMP VALVES AND SEATS • SWABS • VALVES • HAMMERDRILS • CENTRIFUGAL PUMPS

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# of Your Rig ..... by MISSION

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WE MADE THIS cutaway view of a mud pump so you can see just where the vital fluid-end parts fit and why they are essential to correct operation. Your mud pump is one of the hardest working parts of your rig. Forces on these fluid-end parts are staggering. For example, pistons and rods may be subjected to forces of more than 100,000 pounds. These forces may be multiplied by shock loading at times, and they are completely reversed at least once every second. When you remember that mud may contain abrasive sand to cut metal parts; corrosive chemicals to pit them, and oil to attack rubber, it seems obvious that only the best pump parts stand a chance.

LIKEWISE, MISSION MUD PUMP VALVES AND SEATS may withstand pressures ranging from a near vacuum to well over 3,000 psi. In addition to other severe conditions, valves are required to seal perfectly even though mud may be loaded with all types of lost circulation materials.

In this service, only parts of advanced design and materials can stand up. That's why Mission has been a leader in pump parts research for many years.

But, most important, Mission pump parts are built to be used together to give even longer service. Here are some concrete examples.

MISSION PISTONS AND MISSION LINERS work together. Each depends on the other for trouble-free operation.

Both liner and pump bore depend upon the liner packing for freedom from fluid cutting. *MISSION SUPER-SERVICE® LINER PACKING* features exclusive "zero clearance" confinement of packing rings that multiply packing life many times.

Furthermore, accurate machining of the liner outside diameter of Mission Liners means longer life for packing.

Now consider the connection between Piston and Rod. Each depends on accurate taper, precise alignment and correct surface finish of the other. Our gaging procedures are designed and maintained to insure the required accuracy for positive interchangeability of both piston and piston rod tapers.

PISTON RODS AND GLAND PACKING depend on each other for satisfactory service. From an economic standpoint, *MISSION SUPER-CHROME PISTON RODS* and *MISSION SELF-SEALING GLAND PACKING* make an unbeatable combination. The pressure-seal feature of the packing extends rod life while the non-pitting chrome surface of the rods extend packing life.

Now look at Valve Seats. The correct size, taper and surface finish of the seat can prevent costly pump deck washouts. Mission employs some of the most modern manufacturing and quality control techniques to assure perfect tapers.

When you consider that these Mission Pump Parts are in direct working contact with the drilling fluid, it is easy to see that they are vital to correct pump operation. When you remember that they work together for trouble-free service, it makes sense to specify all Mission pump parts—exclusively—in all your pumps. Your pumps will perform better, require fewer repairs and cost less to maintain when you do. The famous Mission Guarantee assures you of this service.

Nothing but the finest will bear the name of **MISSION MANUFACTURING CO.**

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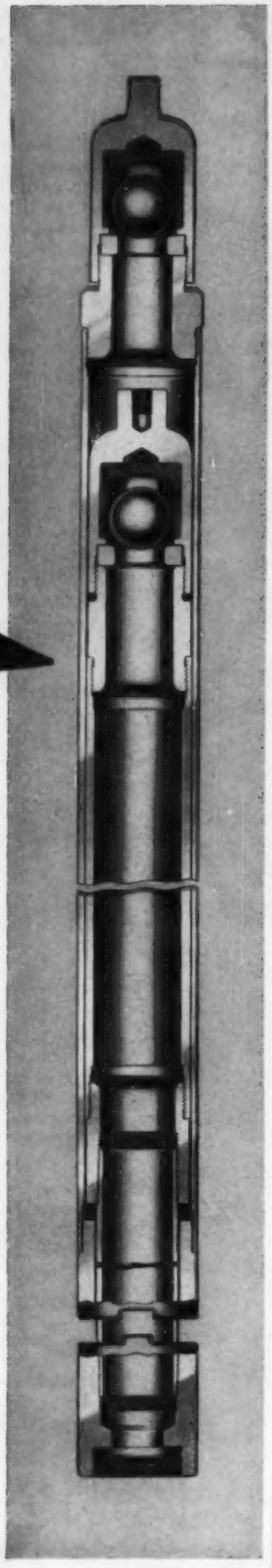
PUMP YOU GET
VOLUME *plus*



1 A precision insert rod pump of 4½" O.D. x 3¾" I.D. built to Pacific standards.

2 A specifically designed pump for pumping large volumes of fluid efficiently **at any speed**—fast or slow—with a conventional pumping unit installation.

3 A pump that will seat in a regular production casing packer and may be operated in 5" casing (or larger) thereby eliminating tubing.

4 A pump ideally suited for pumping water supply wells in the range of 2000 to 3000 barrels of fluid per day for water flooding operations.

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DW-18

Texas Mid-Continent Awards Given to Bass, McCollum

Harry W. Bass, Dallas independent producer, and L. F. McCollum, president of Continental Oil Company, Houston, received Texas Mid-Continent Oil & Gas Association's Distinguished Service Awards for 1958.

The awards, which are given each year to an independent producer and a major company executive for service in the petroleum industry, were presented on the closing day of the association's 39th annual meeting in Dallas, October 7 and 8.

Bass is a former president of the association, and is president of H. W. Bass & Sons, president of Can-Tex Drilling Company, and is chairman of Goliad Corporation, a gas processing firm with operations in South Texas and Canada.

McCollum has been president of Conoco since 1947, a firm which now ranks 15th in assets among U. S. oil companies. Prior to joining Continental, he held executive positions with Standard of New Jersey and its affiliates and with Humble and Carter Oil.

Speakers

Roger M. Kyes, Detroit, vice president of General Motors Corporation and former Deputy Secretary of Defense, was among many outstanding speakers that addressed the annual meeting of Texas Mid-Continent.

Also addressing the Texas oil and gas industry leaders were Claude C. Wild, Jr., Washington, D. C., attorney for the Mid-Continent Oil & Gas Association. He discussed the outlook for legislation affecting the petroleum industry during the next session of Congress.

Other speakers were Robert C. Tyson, New York, chairman of the Finance Committee and director, U.S. Steel Corporation; Henderson Supplee, Jr., Philadelphia, president, The Atlantic Refining Company; Martin A. Row, Dallas, Southwest Division general attorney, Sun Oil Company; and Robert M. Chan, Dallas, director and consultant, Transwestern Pipeline Company.

Besides the slate of speakers, the association's program included the annual golf tournament and the membership dinner on October 7. Highlight of the final day was the presentation of Distinguished Service Awards.

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helps you "beef up" low-solids muds

Low-solids and milk emulsion muds offer you many important benefits by increasing penetration rate, bit life, and in hurdling special problems.

But, being short on solids, these muds have to be "beefed up" to get the viscosity you need to carry cuttings out of the hole.

Low-cost way to do this is with Du Pont High Viscosity CMC, developed especially for low-solids drilling muds.

Du Pont High Viscosity CMC builds viscosity, provides good fluid loss control, and keeps your mud costs down because of the minimal amounts needed to do the job.

You also get excellent suspension of weight materials, high resistance to thermal and bacterial degradation, and a tough, thin filter cake with Du Pont CMC.

For low-solids muds without pain, strain, or runaway costs, call your mud dealer for immediate delivery of Du Pont High Viscosity CMC. Or get in touch with:

Barada & Page, Inc., offices in Corpus Christi, Dallas, Fort Worth, Houston, Kansas City, New Orleans, Odessa, Oklahoma City, Tulsa, Wichita.

Macco Corp., Paramount, California.

Du Pont Explosives Department, offices in Houston, Los Angeles and Wilmington. Warehouse in Farmington, New Mexico.

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IN THE FLUID INJECTION FIELD!

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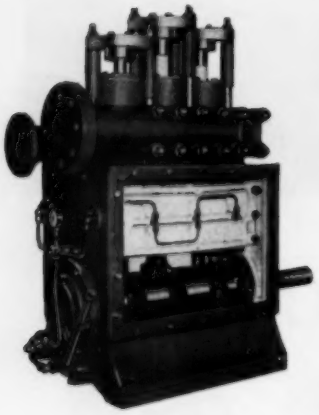
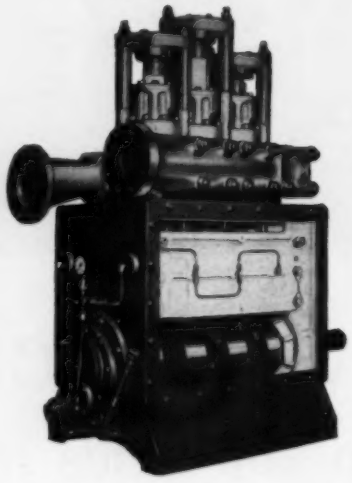
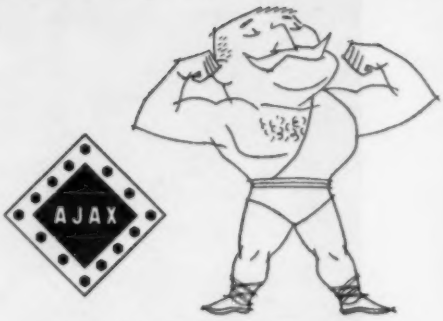


5.2 to 123.5 gpm
Pressures 4980 to 835 psi

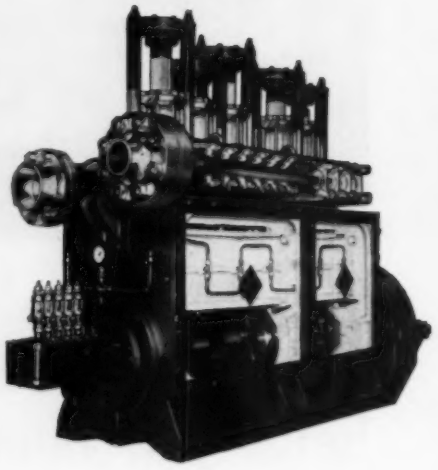
TRIPLEX 5000 PUMP



9.6 to 258.2 gpm
Pressures 4940 to 665 psi



QUINTUPLEX PUMP



16.0 to 430 gpm
Pressures 4940 to 665 psi

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Ajax Vertical Pumps offer a broad range of capacities for fluid injection and down-well pumping demands, with unfailing dependability for pressure maintenance around the clock. In the years since their introduction, Ajax Triplex Pumps have led the field in stamina and low maintenance on the toughest pumping jobs. The new Ajax Quintuplex brings high capacity with the same Ajax top quality construction—and is the *first* pump to feature a crankshaft mounted on THREE double-row, tapered anti-friction roller bearings. Typically AJAX . . . ask your Supply Man for descriptive bulletins!

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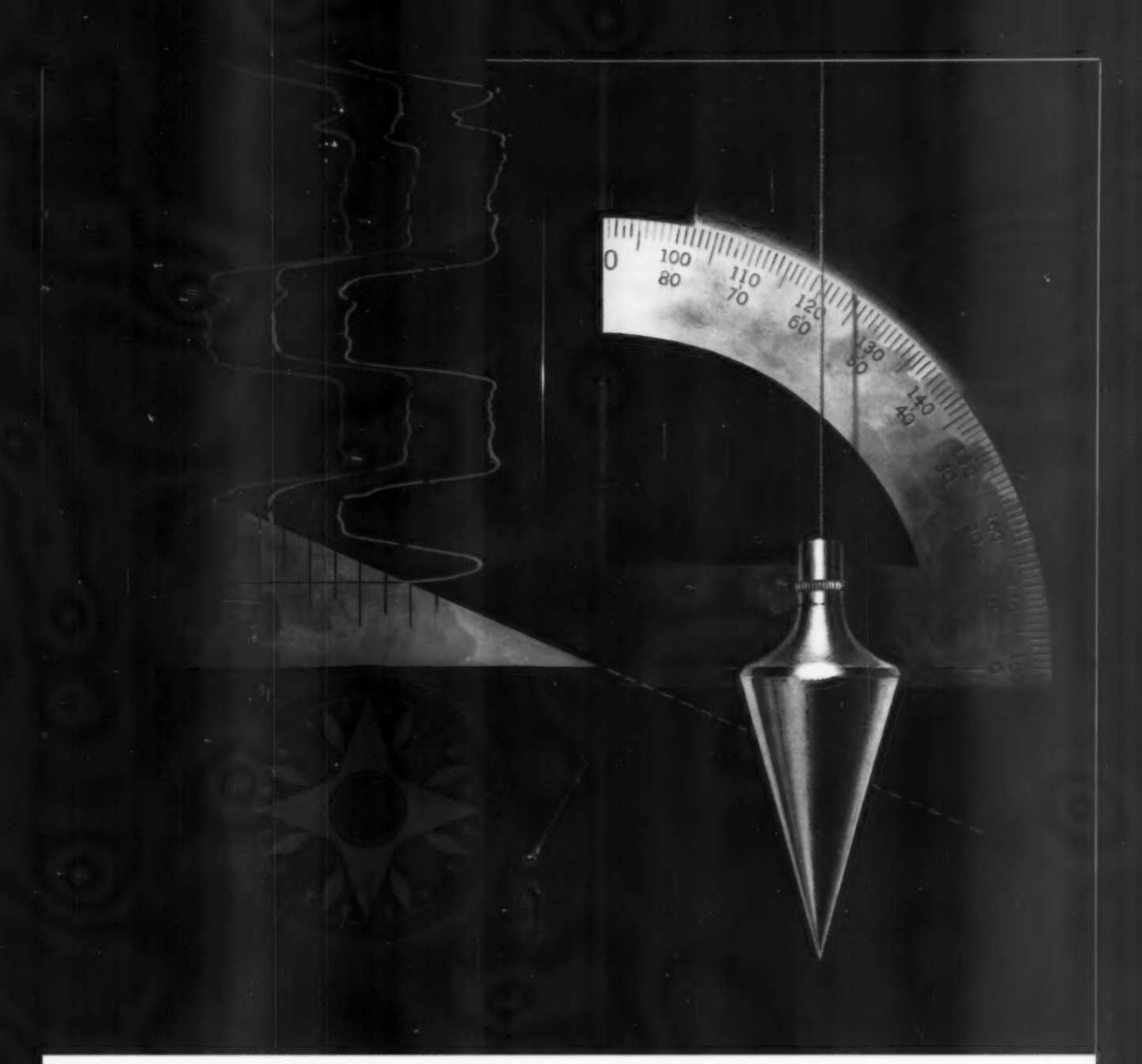

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Use the Schlumberger Continuous Dipmeter on every wildcat well.

As long as oil migrates up-dip, there is nothing more *fundamental* in wildcatting than to find *which* way is up . . . and the Schlumberger Dipmeter can do just that!

Formation dips—both amount and direction—throughout the borehole are recorded in one, fast, continuous operation.

These dip measurements may be more vital to oil discovery in a wildcat area than all other structural information.

The cost? It's small, in both time and money, compared to the cost of drilling additional wells or using other exploration methods.

And now — added advantages from completely new design.

- No special instrument unit necessary. The service is run from the regular logging unit.
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If you are drilling deep wells with heavily weighted muds you may be able to cut mud maintenance costs by as much as 60 per cent if you use the CLAYJECTOR* to recover barite and remove drilled solids. In actual tests, savings of over $1,000 per day have been obtained.

When drilling shallower wells using lighter muds the CLAYJECTOR can make smaller—but still important—savings. It should be considered whenever mud weight exceeds 11.5 pounds per gallon and it will definitely save money whenever 60 or more sacks of weighting material per day are required to maintain the mud.

Other advantages include faster drilling and greater safety that result from closer control of mud characteristics.

The CLAYJECTOR is a four-cyclone drilling mud separator with a simple, easy-to-control feed and dilution unit. It is trouble-free and easy to operate. It is easy to move and install. Furthermore, rental costs are so reasonable that it can be used profitably on many wells where it would be impractical to use more elaborate units.

Extremely high clay-rejection efficiency (averaging about 75 per cent) and high barite recovery (85 to 90 per cent) account for the unusual effectiveness of the CLAYJECTOR. Since a minimum volume of mud need be processed for a given clay rejection, chemical and barite losses are kept to a minimum.

The CLAYJECTOR is engineered, distributed and serviced by Salt Water Control, Inc. It is available on either a rental or lease basis.

Here is a unit especially tailored to the requirements of drilling contractors. For more information, call on your nearest SWACO representative or write us in Fort Worth.

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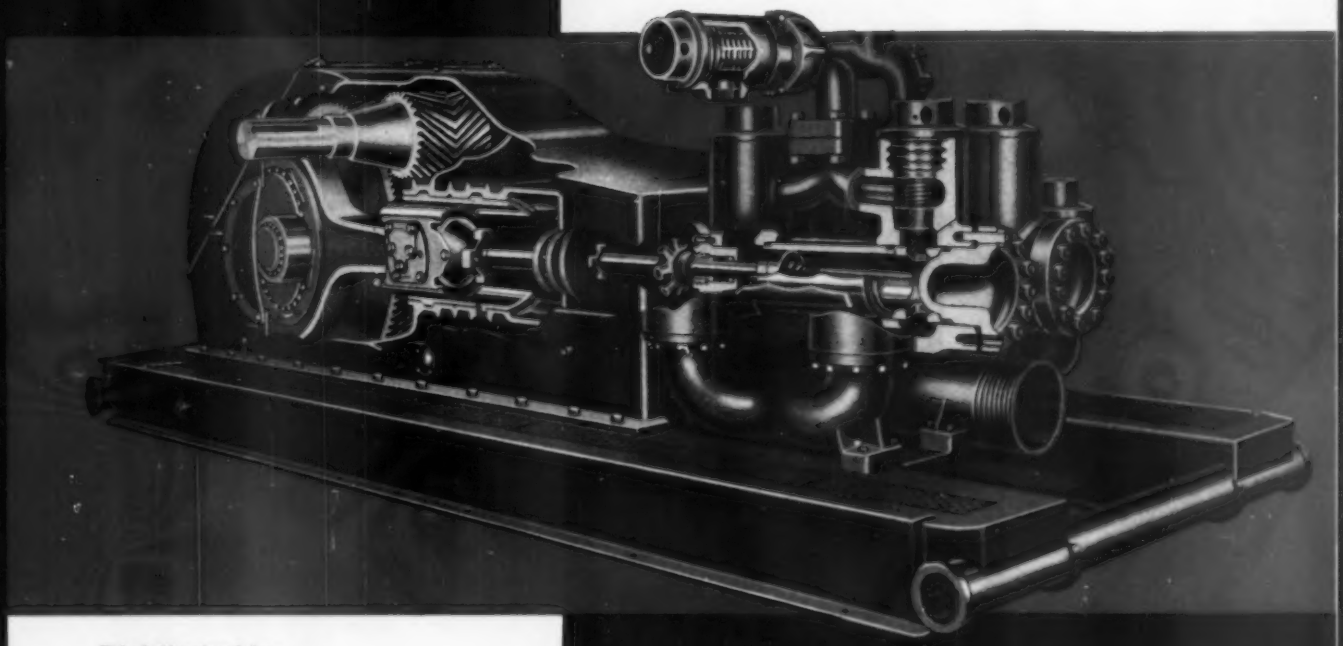
Examine this cross section of a Continental-Emsco Series D Slush Pump. Note how *extra power* has been built into the large main gear . . a wide-faced, forged-steel herringbone gear . . heat treated for years of heavy-duty pumping. The pinion and pinion shaft are integral . . made of high-alloy, forged steel . . fully heat treated.

Eccentrics are equipped with large diameter roller bearings, which results in an extremely narrow and compact power end. The eccentric straps are made of one-piece alloy steel.

You can see how the sides of the power-end housing are not thick, as are solid castings. Steel plates and shapes have been utilized instead of bulky castings to provide a light, rigid power-end. This is *Fabriform construction* . . the big *weight-saving* feature of Continental-Emsco Pumps for lower-cost transportation and easier rigging-up. You get *more horsepower per pound* than in any other slush pump.

Maintenance features are outstanding in the design of the D Series Slush Pumps. Patented "exposed" liner design *minimizes fluid-end washouts* caused by liner-packing failures, and no greasing is necessary, since lubrication is completely automatic.

One of these six Continental-Emsco Slush Pumps will meet your drilling requirements: D-175, D-300, DA-500, D-700, DA-850, D-1000. Ask your supply representative for all the data on these pumps.



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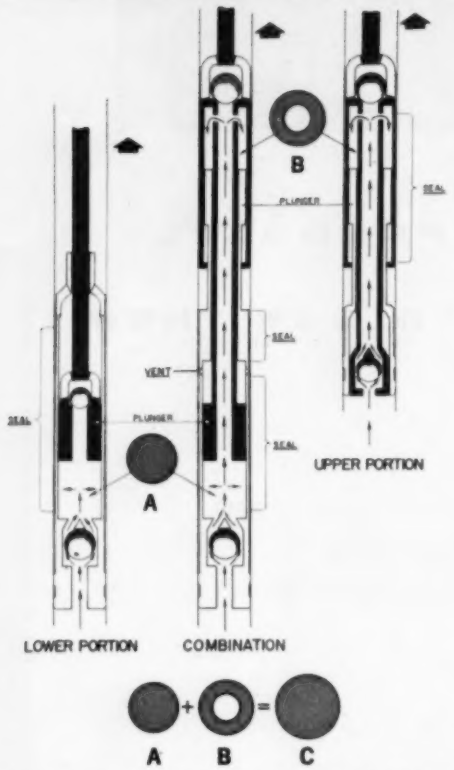
NEW AXELSON VOLUMAX INCREASES PRODUCTION FLOW



Shaded circles indicate volume areas. Plunger area (A) plus annular area (B) result in increased production area (C).

Axelson's new Volumax pumps will outperform any similar pump currently available for 2" tubing.

Special ⅞" liner column uses ⅞" plunger to effectively seal and create an upper telescoping annulus. Resulting production is 22% more than that obtained with a tubing pump.

Lower portion plunger area (A), plus upper portion annulus area (B), combine to provide increased volume (C).

ALL VOLUMAX PUMPS PROVIDE THESE ADVANTAGES:

1. Volumax pumps may be operated at a depth limited only by sucker rod stress.
2. Tandem pump construction provides extreme rigidity of all parts during compression portion of stroke (downstroke).
3. Maximum fluid passage — minimum drag.
4. Optimum plunger fits established through practical field experience.
5. Exceptionally good hold-down ability.
6. An insert pump, tubing need not be pulled.

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Special savings are yours *every day* when you install a field-tested and performance-proven Parkersburg Pumping Unit on your well. Parkersburg units are built for dependable service and low-cost operation. This is a combination that cannot be beat anywhere.

THE PARKERSBURG RIG AND REEL CO.

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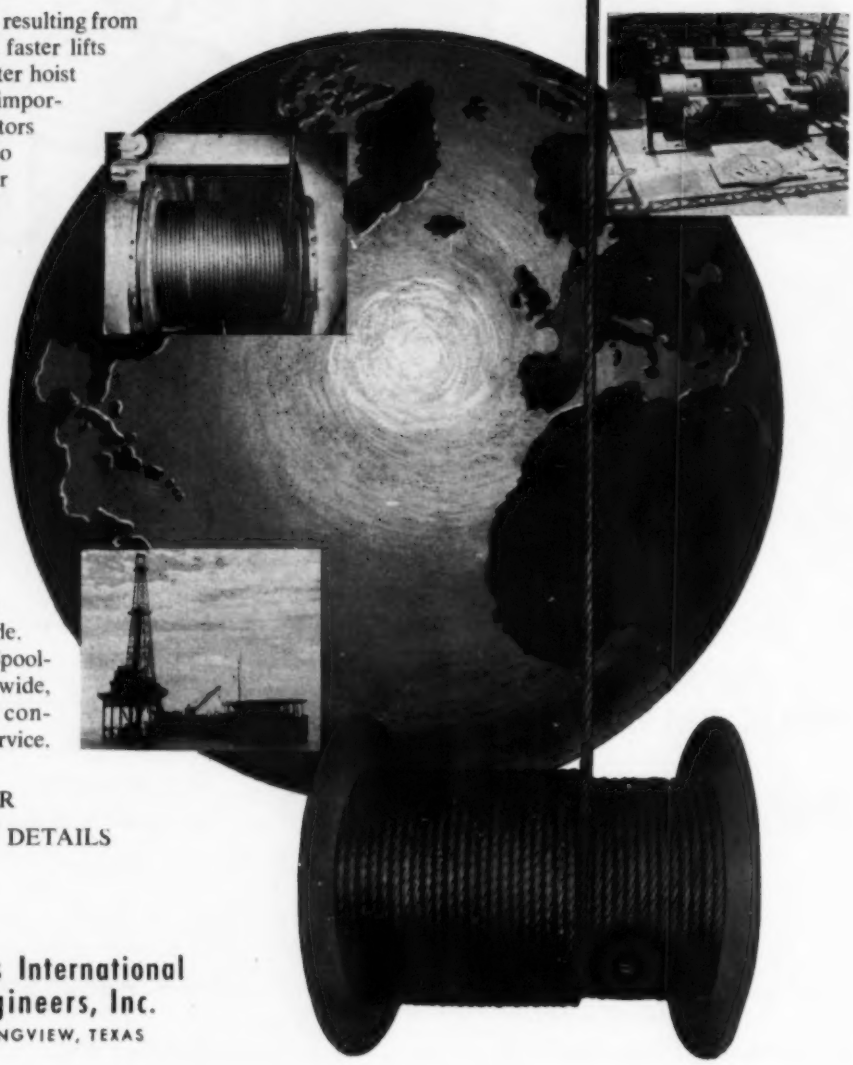

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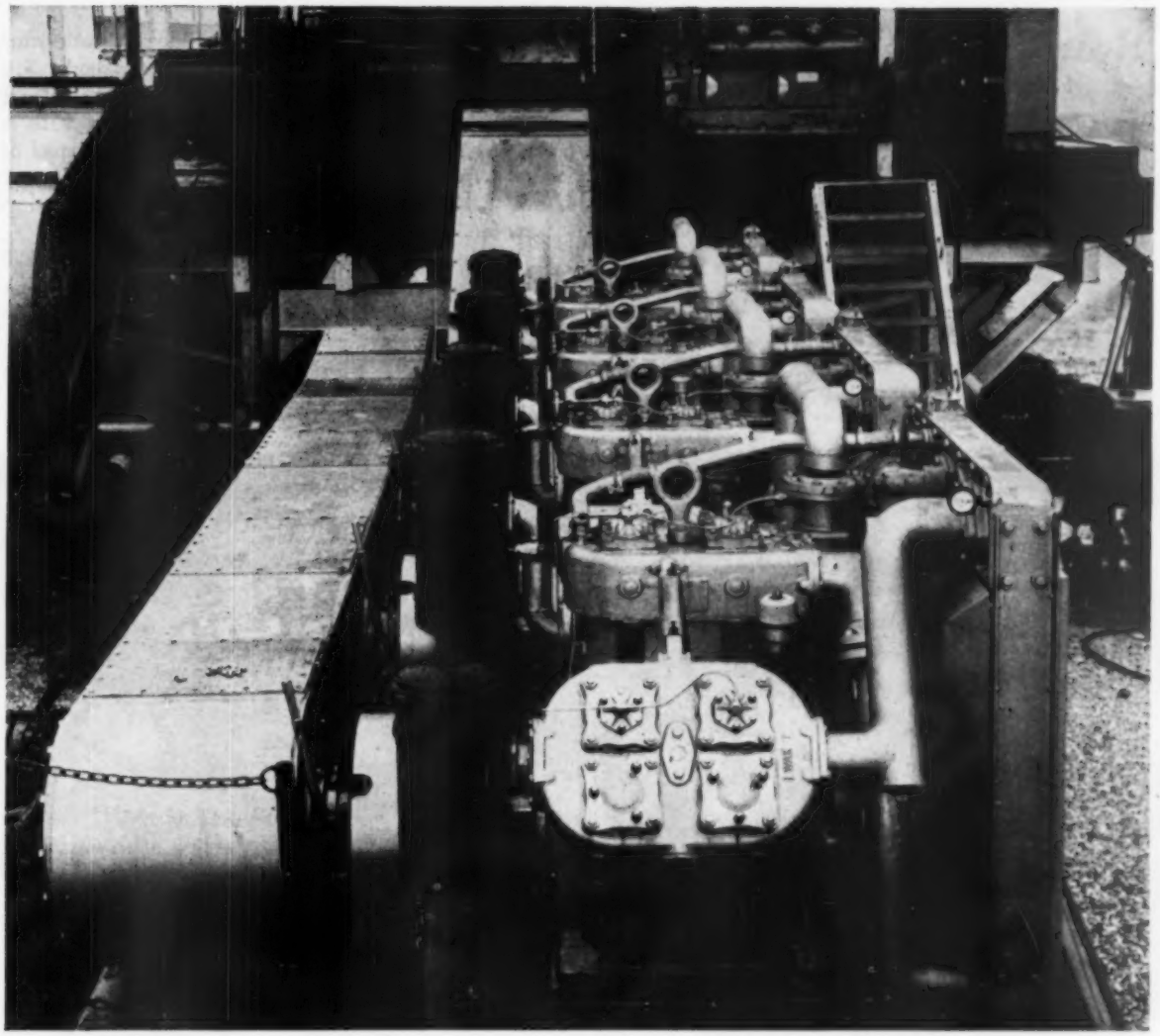

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Is your air drilling project in the planning stage? Here's a compressor package designed especially for it—the Gardner-Denver WB air drilling unit. Each packaged unit consists of water-cooled compressor, intercooler and aftercooler, engineered to deliver cooler air at the header. The WB is built for continuous service and is easily maintained at the drilling site.

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However, continuous probing beneath the earth's surface depends on how much punishment tubular materials can stand. They must be worked hard and deep. They must resist twisting action, fatigue and collapse. And they must be ready to meet the more rigid stresses of deeper drilling tomorrow. You can bet when new records are set USS National Seamless Oil Country Tubular Products will be on the job. They are acknowledged the world over as the most ideal materials for deep well work because their strength and dependability can be attributed to two vital factors—quality steel and a unique way of manufacture. Each seamless tube is pierced from a solid billet of steel. And only steel of the very best forging properties and of the highest uniformity can be used, since the modern piercing operation tends to search out any defects in the metal.

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Some of National Tube's most notable contributions to the oil industry:

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For further information, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Export Distributors: United States Steel Export Company, New York.

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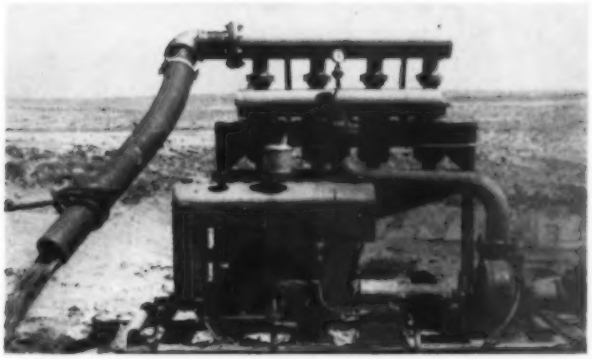
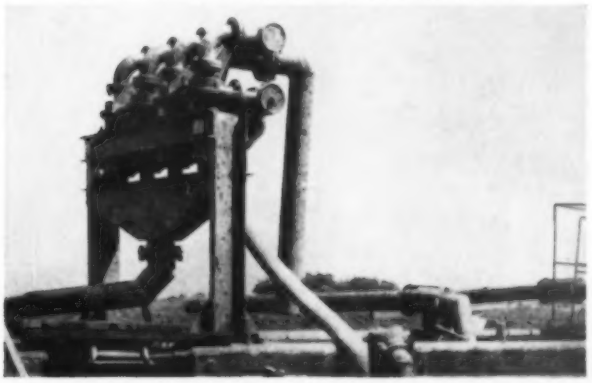
field proven for rig time and maintenance savings



These #4 Dorrco D-Sanders installed above in San Juan Basin, New Mexico, and below in Cleveland County, Oklahoma, illustrate the versatility of the unit for either operation in conjunction with pit or detached and mounted above mud tank (this is a modified unit).



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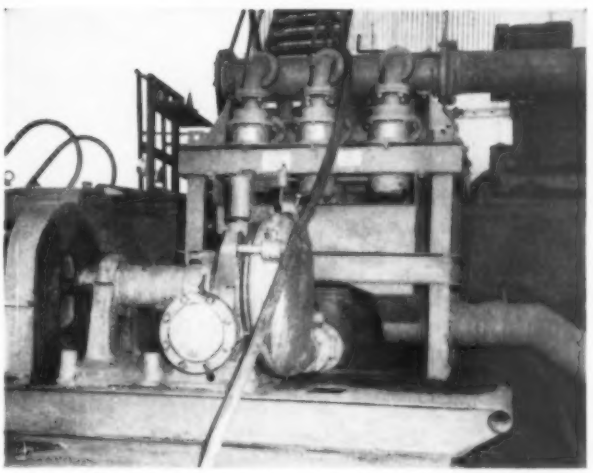
Field proven on over one hundred rigs throughout the world, the Dorrco D-Sander has consistently given a direct rig saving of thousands of dollars per well.

Available in three standard sizes with mud capacities (at 20 psi operating pressure) from 200 to 800 gpm, the Dorrco D-Sander is the best answer yet to the problem of sand accumulation in drilling muds. The unit provides a means for continuous removal of sand-solids and delivers to the mud-pump a non-abrasive mud containing less than 0.2% API sands.

For more information on the Dorrco D-Sander, contact our U. S. Sales Representative, Salt Water Control, Inc., 1211 Fort Worth National Bank Building, Fort Worth 2, Texas.

D-Sander T.M. Reg. U. S. Pat. Off.



No. 6 Dorrco D-Sander installed on an Oklahoma rig drilling ahead to new record depths.

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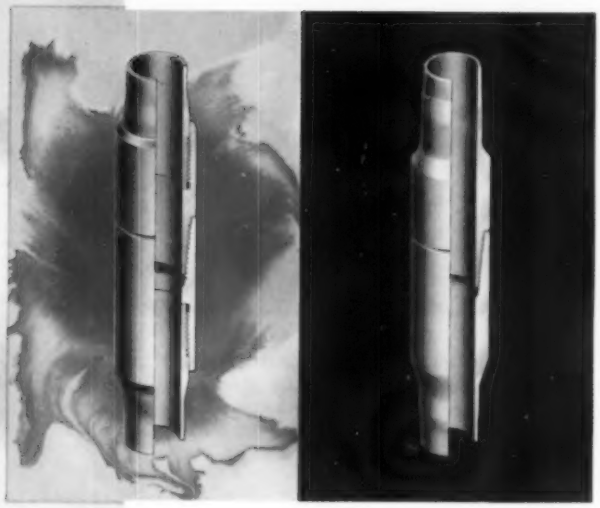
for light weight drill pipe



Reed Wide Open Tool Joints for light weight drill pipe are available in either Super-Shrink Grip or Flash Welded.

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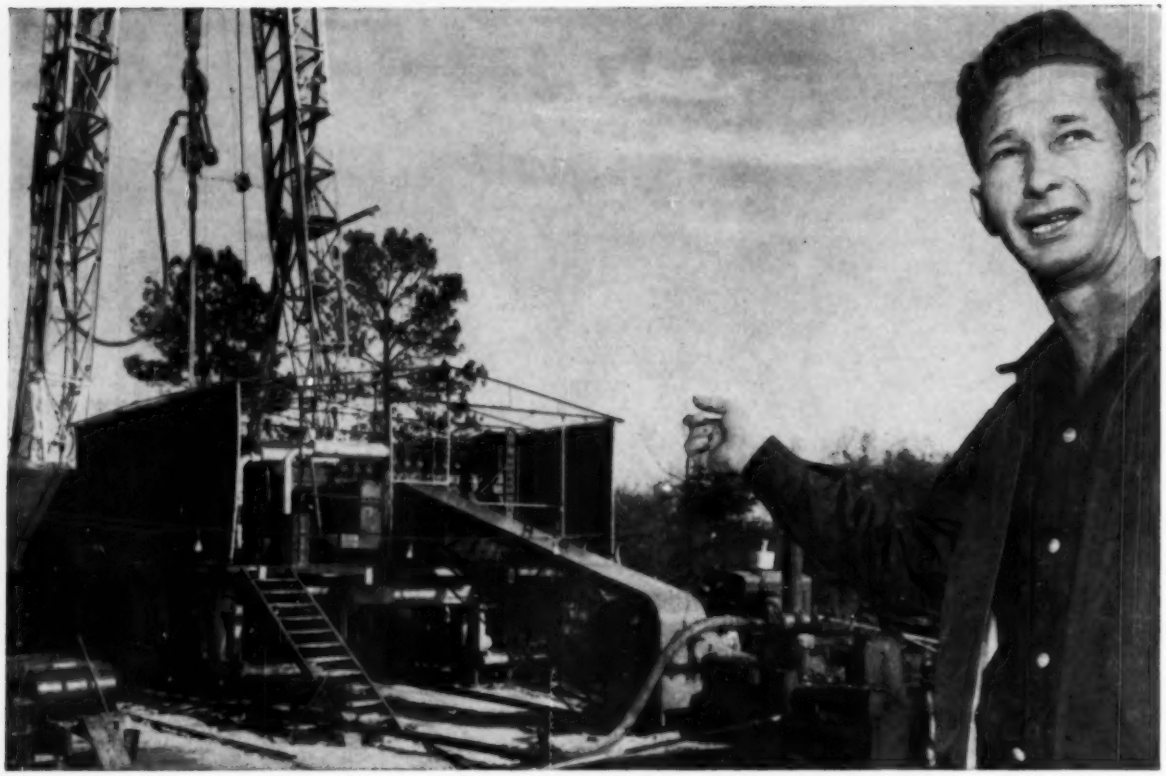
Multi-Matched Dayton V-Belts Give Us 2 to 3 Times More Service



"In 16 months of service," says W. T. Patton, drilling superintendent for the Carter-Jones Drilling Company, Inc., "this set of Dayton Multi-Matched V-Belts has pumped mud for 12 holes averaging 8,000 feet in depth. And, they've never caused a minute's delay during this entire time.

"On the average, Dayton V-Belts give us 2 to 3 times more trouble-free service than any belts we've used—that's why every one of our rigs is 100% Dayton equipped."

"On the job for over 16 months, this set of Dayton V-Belts will give us another full year of trouble-free service.

"We set a fast pace that's tough on V-Belts. On this job we punched 950 ft. in 6 hours and 1400 ft. in the next 24 hours. In the final stages, we still drill 150 ft. a day. Only by using the best equipment available—like Multi-Matched Dayton V-Belts—can we keep our production lead while holding costs to a bare minimum.

"Service is no problem either. Our Dayton distributor, Jack Anderson Company of Kilgore, Texas, gives us around-the-clock service within a 600-mile radius."

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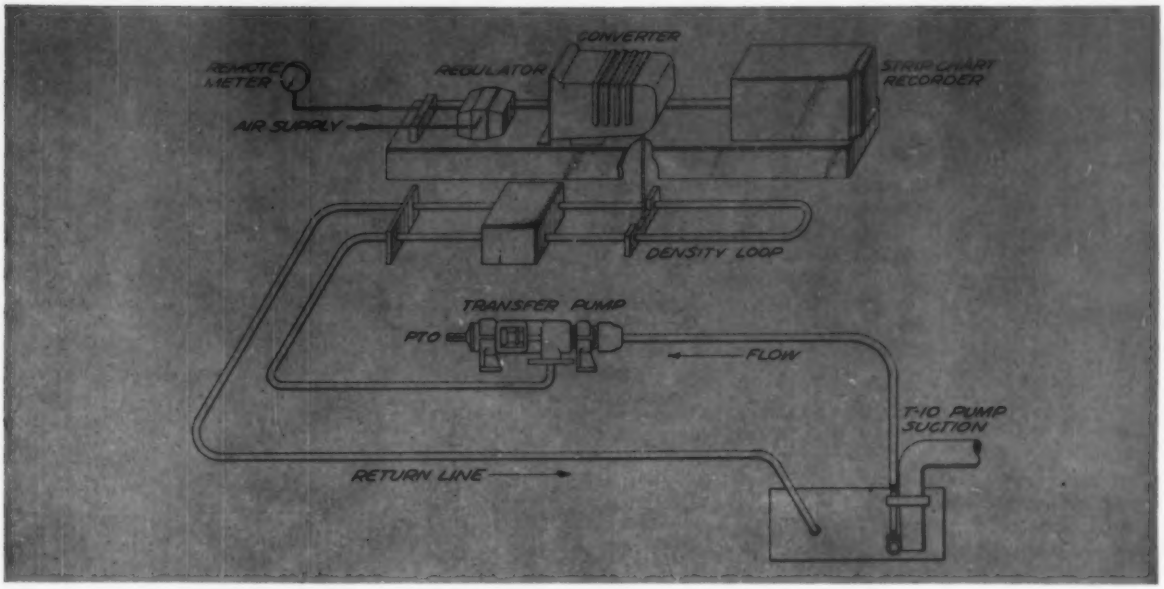

FIG. 1. **Schematic drawing** of density meter as used for measuring slurry weights of cement. Weight of sample in density loop is measured and recorded on strip chart.

New density meter provides . . .

Improved Cementing Through Automation

Instrument continuously measures cement-slurry weight and makes a strip-chart record of measurements. Applications are seen for control of mud weight

George V. Copland and Dwight K. Smith,
Halliburton Oil Well Cementing Company, Duncan, Oklahoma

SINCE THE INTRODUCTION of bulk cement to the oil industry there has been a continual search for instrumentation that would accurately measure the density of the cement as it is pumped into a well. From what was once a two-component cement slurry system consisting of cement and water with a weight range from 15 to 16.5 lb per gal, improvements in cementing compositions now make it possible to reduce or increase the density of a cement slurry from 10 to 20 lb per gal. The control and accurate measurement of such a wide range of densities in different cement systems has been made possible with the development of a new slurry weighing device called a Densometer.

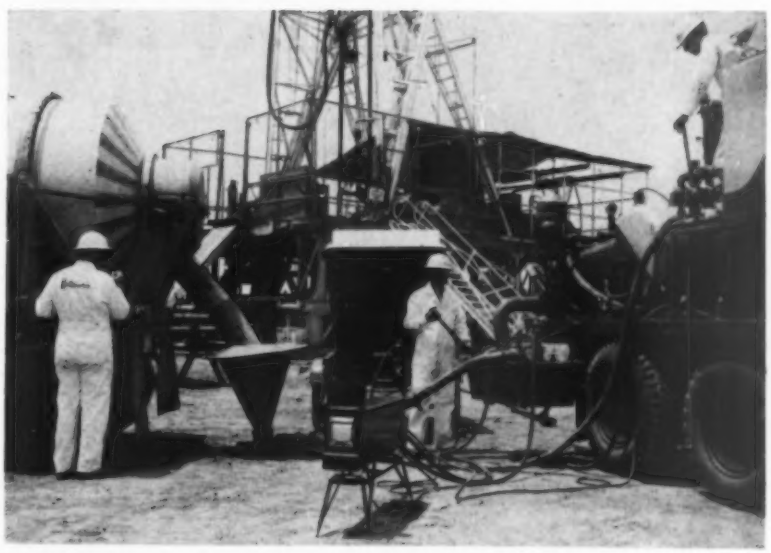

FIG. 2. **Density meter** (center foreground) used during actual cementing operation. A remote gage is mounted on the cementing truck. The entire system is carried in a small trailer.

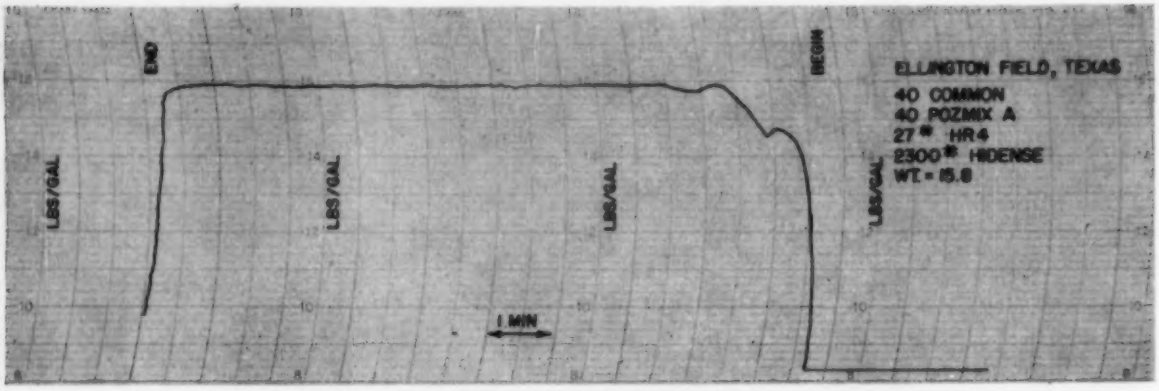

FIG. 3. Strip chart made by instrument during typical cementing job. Graph is read from right to left and shows a slurry weight of approximately 15.8 lb per gal during pumping operations.

This density meter will accurately weigh and record cement slurries over a wide range of weights that are accurate within one-half of one percent and has a response time of less than three seconds. Basic design of the instrument utilizes an adaptation of the beam balance system (Fig. 1) which measures the fluid by a hollow beam scale. The beam of the scale is a U shape and is constructed of copper tubing. This is supported by a pivot system and a modified differential converter. The differential converter measures the weight of the U-tube and fluid and converts this to a pneumatic signal which is proportional to the weight of fluid within the tube. A pneumatic strip chart recorder provides a continuous record of the fluid density. Remote gages may be provided at any point for visual readings throughout the cementing operation.

Field tests using the meter have shown it to be a durable and accurate instrument. A typical set-up of the meter on field job with the unit being mounted in portable trailer is illustrated in Fig. 2. In the foreground is the recorder which provides a continous strip chart throughout the cementing job. A strip record taken from a small cementing job using 80 sacks of pozzolan cement, weighted to a density of 15.8 lb per gal, is shown in Fig. 3. Slurry samples are taken directly from the intake manifold leading from the cement mixing tub and are returned to the manifold in the system. The remote gage that may be used with the meter offers immediate observation in weights in the event changes are desired by the operator.

Presently the instrument is being manufactured in three ranges depending on the desired weight: 8 to 18 lb per gal, 6 to 21 lb per gal, and 50 to 150 lb per cu ft. Various mounting arrangements are also used which include small trailer units, truck mounting, or separate installation for applications other than oil well cementing. Although there is a large number of cement additives, experience to date has shown that materials in the particle range for lost circulation control can be successfully handled through the density meter.

While designed primarily as a cement weighing device, this instrument has found applications in other phases in the industry where weight may be critical and must be maintained in narrow limits for long periods of time. Such an application is in the mud system on

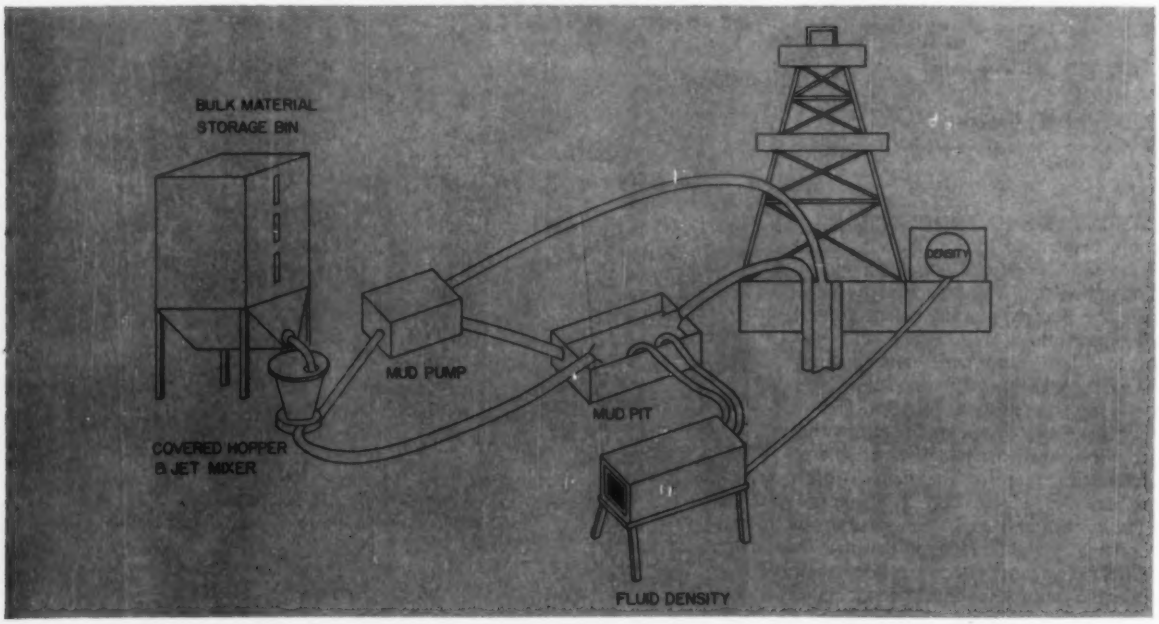

FIG. 4. Schematic drawing shows use of density meter to measure mud weight during drilling operations.

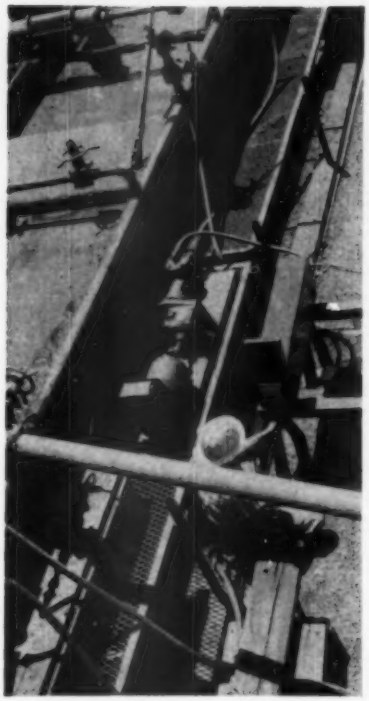

FIG. 5. **Density meter** in use adjoining mud pits. A remote gage is mounted on rig floor in addition to strip chart recorder.

a drilling rig. Fig. 4 illustrates a typical lay-out utilizing the meter for maintaining the control of slurry weight for this application. The drilling fluid is continously sampled by the instrument, making it possible for a rig crew to have an accurate recording of density of the mud system through a remote gage on the rig floor plus the information recorded on a chart for future use. This reduces the possibility of error in spot checks of mud weight at different times through daily testing.

A photograph of the instrument located at the suction of the mud system is shown in Fig. 5 for the continuous weight application. This instrument may be especially helpful in drilling areas where high-pressure gas or air pockets are encountered. The occurrence of such pressures may not necessarily be confined to deep hole country along the Gulf Coast, as experience has shown that even in the shallow gas sands in Northeastern Oklahoma, located at depths of 600 to 800 ft, gas entrainment can be readily detected in slurry density. The meter would enable the immediate identification of these trouble spots in the mud system.

Maintenance of the instrument in a mud system requires about 10 minutes attention on every rig tower for lubrication and adjustment of the packing on the transfer pump. No other service is required for the instrument utilized for drilling mud. The remote gage on the rig floor or in the doghouse keeps the rig crew informed at all times of mud weight. The strip chart offers a ready reference for the mud engineer looking for troublesome mud areas or in detecting possible light or heavy zones in the drilling mud system. This is particularly important where the mud weight is critical and variance of only a few tenths of a pound per gallon is permitted. The meter can be helpful in areas where blowouts are of constant concern if the mud becomes too light or where lost circulation is a problem when mud becomes too heavy.

While to date the density meter has been used primarily for these two applications, i.e., weighing of cement and weighing of mud, there are possibilities of other applications where continuous and accurate weighing with such an instrument would be beneficial in controling density of oils or other similar fluids.

Research efforts are now being made to investigate the possibilities of measuring viscosities of a fluid or slurry and recording it simultaneously with the weight using the same instrument. Time will show if this added property of viscosities can be utilized to the fullest extent with this type of instrumention.

* * *

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On offshore rigs the reclamation of mud is vitally important and the separation of shale and abrasives from drilling muds means a more effective, time and money saving drilling job. Barnwell Offshore, Inc. chose Thompson for their new offshore rig, the VINEGARROON, because is was field proven, will give them clean mud and make tools last longer, with a minimum of re-tooling and restoration of mud solution.

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EXPLORATION ACTIVITIES

CALIFORNIA

Signal Finds Gas In Second Rancho Test

A second successful test on Signal-Richfield-Rancho No. 1, the exploratory well on Rancho Park in West Los Angeles, was reported by Signal Oil and Gas Company. The same well, operated by Signal for itself and Richfield Oil Corporation has already discovered a new oil producing area in the initial test.

In the new test, made in a 635-ft interval above that tested previously, the well produced gas on a stabilized basis at rates up to 2,800,000 cu ft per day through a 18/64-in choke. The well also produced 56.6 deg oil at rates up to 310 bbl per day. Tubing pressure was 2350 psi.

The first test showed 34 deg oil at the rate of 343 bbl per day from a 230-ft interval bottomed at approximately 9500 ft.

Geologic opinion is that this represents a new productive area. Signal is operator for itself and Richfield Oil Corporation, and the well is part of an exploratory program which includes nearby Hillcrest Country Club.

The 180 acre city-owned Rancho Park is a part of a 2500 acre block in the area. The well was drilled and tested under the most exacting of conditions. The drilling tower and other structures have been camouflaged and landscaped in such a way that they blend into the surroundings. Extensive equipment was installed and used in the testing procedures to insure maximum safety by containing all vapors and liquids in a closed system.

On Hillcrest Country Club, where Signal is drilling another exploratory well, Signal-Richfield-Hillcrest No. 1 was reported to be drilling ahead at 8950 ft. The private golf course is immediately east of city-owned Rancho Park.

ALBERTA

New Producing Formation Found in Red Earth Well

Union Oil Company of California recently completed the Red Earth 4-20 H on its large Red Earth block in northern Alberta. From a new producing horizon, the Slave Point the well flowed for 140 bbl per day of 38.5 gravity clean oil. Minor showings have previously been noted in this limestone formation in earlier Red Earth wells but this is the first one with sufficient porosity to obtain production.

This new producing horizon is stratigraphically higher than the Granite Wash formation from which all of our previous wells have been completed. Red Earth is Alberta's biggest Granite Wash oil field and the presence of Slave Point production now presents the encouraging possibility of dual objectives in certain areas on our block.

TEXAS

Texaco Gets Atoka Lime Discovery in Panhandle

The Texas Company announced the discovery of a new oil field in the Texas Panhandle, making an important strike in the Atoka lime in Lipscomb County.

Flowing 304 bbl of 47.5 deg oil through a half-inch choke on the initial test, Texaco's Anna Frass No. 1 was completed at the 7903-14 ft interval. Tubing pressure was 150 psi and the gas-oil ratio 2070 to 1.

Nearest production is approximately seven miles southwest of the discovery well.

FRANCE

BP Drills Deep Tests, Finds Shows in Voiron Area

The first deep test well in southwest France for the Societe des Petroles de Valence, in which the British Petroleum group has a 50 percent interest, has now reached a depth of some 5000 ft. This test well is in the St. Julien-en-Born area on the southwest coast for which the company received an exploration permit last year.

Societe des Petroles de Valence is also searching for oil southeast of Lyons. In the Voiron permit area, which covers territory on both banks of the River Isere, two test wells are being drilled. In the south, the Beauregard-Baret No. 1 well has reached approximately 6500 ft and the Brezins No. 1 well further north, 6000 ft. The latter well has given a number of slight indications of oil. In the northeast of the Voiron permit area a seismic team is continuing its survey.

OKLAHOMA

Trice Seeks Bromide Pay in Dry Area

Trice Production Company has staked location for a 4600 ft semi-wildcat offsetting a long-abandoned gas well in Garvin County, south central Oklahoma.

Trice's No. 1 Rickert, one mile south of the township of White Bead, will test First and Second Bromide sands similar to those in which oil and gas were tested in the Duncan No. 1 Tolbert. The No. 1 Rickert is a north offset to the Tolbert, completed in 1945. The Tolbert was abandoned after a few months because of uncontrollable salt water flow.

The operators indicated they believe that introduction of selective completion techniques since the Tolbert was drilled now will make it possible to obtain successful offset production from the same horizon. The No. 1 Rickert is on the 275-acre Rickert et al lease. Dodson Drilling Company is contractor.

TURKEY

Bolsa Chica Finds No Oil in First Well; Second Test Underway

Bolsa Chica Oil Corporation "Zengilan" No. 1, the first in a series of exploratory wells to be drilled by the company and its associates in the Republic of Turkey, has been abandoned at a total depth of 6449 ft, no significant oil showings having been encountered. Geological information obtained from this well, however, indicating that it was located off the axis of the subsurface fold at depth, will be of value in locating a later test of the Zengilan structure.

Drilling equipment has now been moved approximately 17 miles east of "Zengilan" No. 1 where location has been made for Bolsa Chica Oil Corporation "Hazro" No. 1, the second well scheduled in the drilling program planned for the inland block of 370,000 acres held by the company and its associates. Drilling operations on this second well, which is on a separate closure of considerable magnitude, began in the middle of October. It is estimated that a total depth of 6000 ft will be sufficient to test this structure.

As in the case of "Zengilan" No. 1, substantial dry-hole contributions have been pledged toward the drilling of "Hazro" No. 1 by major oil companies holding licenses in the general area.

Each reservoir fluid has its own unique characteristics. The sooner these critical pressure-volume-temperature data are pinned down and understood, the sooner an operator can take a more tangible look into the economic future.

He needs this P-V-T information for estimating the quantity of stock tank oil in place, the amount he may expect to recover, and the field procedures best suited to sustain the reservoir's optimum productive ability.

But major changes in the properties of reservoir fluids occur as the field is produced and pressure declines. Therefore, the most effective recommendations and predictions are made from analyses of subsurface or recombination samples obtained *early in the life of key wells.*

Core Lab, operating the industry's largest and most modern commercial reservoir fluid laboratory, has blueprinted the long-range recovery patterns of, not hundreds, but thousands of different producing horizons. This experience factor is added to the data you receive.

Beat your future to the draw. Act *now*. It's never too early — but it can get too late.

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Exploration

NEBRASKA

Enders Area Prospector Finds "J" Discovery

Drilling and Exploration Company, Inc., et. al., are in the process of completing the Number 1 Forest Hinshaw as a "J" Sand discovery in the Enders area of Kimball County. This wildcat, located in Section 12, Township 13 North, Range 55 West, is approximately 2 miles northeast of the Enders field.

After fracturing, the well swabbed at the rate of 20 bbl of oil per hour for 12 hours from perforations at 6202—6207 ft. Preparations are now being made to install pumping equipment. The group has a solid block of approximately 3500 acres in the immediate vicinity of the well.

WYOMING

Mountain Fuel Drills Deep Test On Cataract's Wyoming Farmout

Mountain Fuel Supply Company announced that location is complete and they are spudding an exploratory test for oil and gas located in the SE Sec 13, T 23 n, R 110 w, Sweetwater County, Wyoming. This well will be carried to a total depth of at least 8500 ft and will test the entire Mesa Verde formation.

Cataract has a royalty interest, together with a one-eighth interest in a 20,000 acre block surrounding the drilling site. This first test well shall be drilled free to Cataract, at Mountain Fuel's sole cost.

The well is located approximately 20 miles southeast of the LaBarge Oil and Gas field and is located in an area with favorable geology, but which has sporadic drilling. A lateral from the Pacific Northwest Pipeline is located very close to the well location.

The leases are located in the booming Green River Basin of southwestern Wyoming. Three new important gas discoveries have recently been made in this basin.

PANAMA

Texas American Acquires 225,000-Acre Lease Option

Texas American Oil Corporation has acquired an option to purchase a 225,000 acre oil and gas concession in the Republic of Panama. The large oil and gas concession was acquired from Jaranimo Almillategui, the former vice president of Panama and former ambassador plenipotentiary to the United Nations from Panama.

The new oil and gas concession directly offsets Champlin, Kerr-McGee and Southland Royalty's concession on the east where Champlin, et. al., is now drilling a deep wildcat test well.

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Cameron Weight Indicators show weight on bit (in pounds, not points) with the greatest reliability. Being strictly mechanical in design, there is no chance of high pressure fluid leakage or temperature reflections to affect readings. Your bit will bite into any formation with exactly the right pressure for peak drilling efficiency. All bottom hole operations requiring precise weight control are easier when you COUNT ON CAMERON easy-to-read weight indicators — best on any rig.

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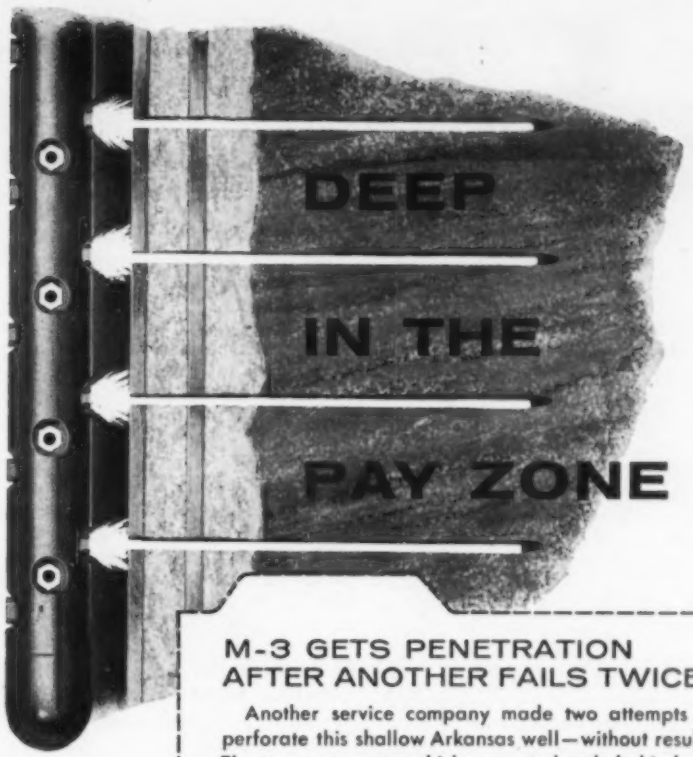
JENSEN JACKS

McCullough puts the shots where they count...®



M-3 GETS PENETRATION AFTER ANOTHER FAILS TWICE*

Another service company made two attempts to perforate this shallow Arkansas well—without results. There was an extra thick cement sheath behind the casing at the perforating interval.

Well was reperforated with 24 improved ½" Ogival Bullets fired by a $5^{7}/_{16}$" OD McCullough M-3 Bullet Gun and is now pumping 10 barrels of oil daily—a normal well for the field.

Depth of operation was 2636'. Casing was 7" OD 20 lb. Operation required 2 hours rig time. Operator was well pleased with results obtained by M-3 Bullet Gun and also with time on job.

McCullough® M-3 BULLET GUNS

M-3's WILL OUTSHOOT any other bullet guns available. Their greater power has been demonstrated in competitive surface tests, in adjacent wells in the same oil field, and in wells where competition has tried and re-tried, as shown above. M-3's consistently get more oil. They'll penetrate excessive thicknesses of casing and cement and get production—even after others have failed.

M-3's EVENLY SPACED, DEEP PERFORATIONS result from McCullough's exclusive firing method—"simultaneous" progressive pressure firing. Shots are fired very rapidly, progressively from top to bottom, at one firing. The M-3 Gun does not have time to "jump" due to the micro-second firing interval from shot to shot, thus perforating pattern is uniform. There is no damage to casing since all shots are fired progressively.

All "selectively fired" single-shot firing guns will "jump" with each shot fired, producing random spacing and scattering of perforations; unfired shots remaining in a selectively fired gun will develop leaks, dampening of powder loads, and loosening of electrical connections thereby causing inferior penetration for succeeding shots.

***The job described above is certified to be a true field report of service rendered.**

Check these "plus" values you get only in M-3 Guns:

- *Uniform hole spacing in casing—most important to avoid casing damage.*
- *All shots fire progressively—gun at rest in selected zone.*
- *Guns fire one to 6 shots per foot.*
- *Up to 30' of guns may be run at one time, perforating 30' of zone in one run—number of holes per foot desired.*
- *Improved Ogival Bullets give best penetration—proved in steel, Berea Sandstone and through multiple casings.*
- *Strongest, safest gun body made—demonstrated in competitive endurance tests.*

McCullough
TOOL COMPANY
Service Locations in all Principal Oil Fields in U. S. A. and Canada
Service ANYWHERE ANYTIME

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

What's doing in DRILLING

Drillers See Little Chance For Activity Boom

After reaching a six-month peak of 2093 on September 15, the combined number of rotary rigs operating in the United States and Canada decreased to 2022 before reaching a total of 2046 active rigs on Oct. 6. The September 15 total of 2093 was the highest number reached since March 3 when 2109 active rigs were reported. The current figures also show a reduction of approximately 600 active rigs from totals reported during the same period last year.

Drillers are not expecting the usual yearend increase in drilling activity to reach the proportions recorded in previous years. J. U. Teague, president of the AAODC, said at the 18th annual meeting of the association that it will be a long time before the nation's oil industry will again have a need for 3000 active rigs. Speaking to organization members at the Dallas meeting, Teague said, "I would caution you against assuming that an end to the current business recession and a resumption in increased demand for oil will result in an immediate resumption of boom levels such as we had in 1956."

Teague said that in order to cut costs, oil producers will eliminate the drilling of unnecessary wells. Wider spacing between wells, multiple completion of one well, and increased emphasis on gas production requiring fewer wells will also tend to keep the lid on a drilling boom.

Largest Inland Barge Receives Safety Award

Superior Oil Company's Rig 23, aboard the W. M. Keck, Sr., the world's largest inland drilling barge, has been honored for completing more than 50,000 man-hr without a single lost-time accident. The award, first of its kind made by the company, was presented by W. S. "Slim" Law, general superintendent of the company's Lafayette District. J. B. Harrist, of Houma, La., and Jim C. Winfiele, also of Houma, both tool pushers on the rig, accepted the award for the drilling crews.

Engineers at R. G. LeTourneau, Inc., of Longview, Texas, check operational characteristics of a new type "wide base" offshore platform. Vice President R. L. LeTourneau, center, said angled legs offer greater platform stability and operational flexibility than any other design yet conceived. The company probably will embark on building such a platform later this year. Others in photo are company marine engineers, Sherman Barber and W. G. Roberds.

University to Offer Course In Blowout Prevention-Control

A program to train oilwell drilling personnel the prevention and control of blowouts is offered by the Petroleum Extension Service of the University of Texas. The course is designed to teach toolpushers and other supervisors why blowouts occur, how to prevent them, and how to bring them under control if they do happen. The course was validated by a joint committee of the American Association of Oilwell Drilling Contractors and the American Petroleum Institute.

Insurance Coverage Tailored for Drillers

The first package insurance plan made available for drilling contractors has been placed on the market by the Liberty Mutual Insurance Company. The package includes workmen's compensation, general liability and fleet insurance, and features a new physical damage policy especially devised to cover drilling rigs.

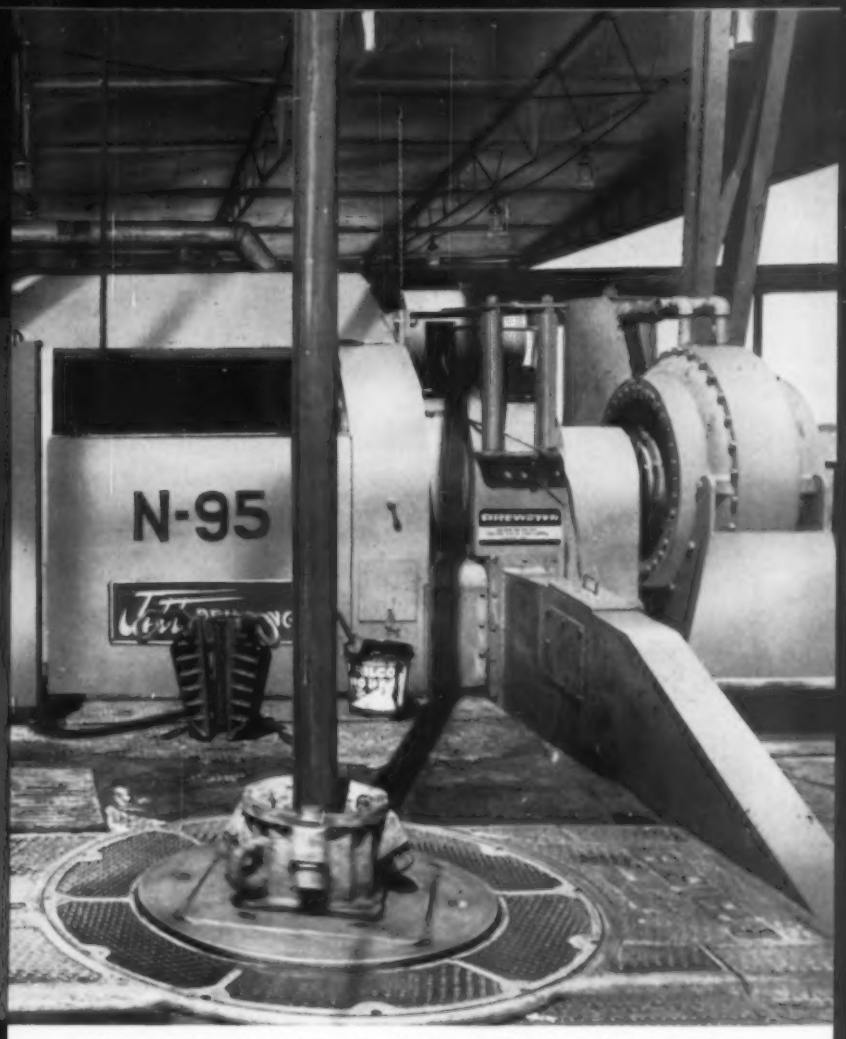
The policy carries along with it the use of Liberty Mutual's staff of loss prevention specialists trained in eliminating job hazards, in establishing simple and effective safety programs, and in training drilling crews in emergency procedures. A company official said that the special rig coverage can be written to cover either stacked or operating equipment, or both, and that new rigs, and additional equipment up to 10 percent of the value of each rig, are automatically covered when reported within 30 days of purchase.

Huge Rig Will Fly To Guatemala

Brown Drilling Company has contracted to fly a new $1,000,000 rig into the wilds of Guatemala to begin a drilling program for Ohio Oil Company. The rig will be shipped by water from Houston to Puerto Barrios, on the Atlantic Coast of Guatemala, and will then be flown in packages of less than 16,000 lb into the Peten area, nearly 100 miles inland. Crews have been at work in the jungle for nearly a year chopping out an airstrip and a road leading to the drilling site.

Shipment of all components of the rig, with capacity beyond 14,000 ft, is scheduled no later than January 1, 1959. Brown crews will shoot for a spud-in date of early March.

BREWSTER N-95 DRAWWORKS



JETT DRILLING COMPANY, INC. Rig 110 with a Brewster N-95 drawworks is now on its third 14,000-foot well.

You hear Brewster customers everywhere use this phrase when they describe the Brewster N-95 drawworks. From pump drives to drum it has been designed to take it on the chin and come up ready for even tougher going. Rated for 12,000-foot plus drilling, the N-95 has the reserve power to go on down profitably.

Flexible in design, the N-95 moves, operates economically and can be used on wells usually drilled by much smaller equipment. The drawworks is side skidded and can be separated from the compound by disconnecting one chain. The controls, auxiliary brake and drawworks move as a single unit without any disassembly.

Brewster Drawworks are built to do the job for which they are sold . . . they're not little rigs "built-up" or big rigs "cut down."

Check these exclusive features that you get ONLY when you buy a Brewster N-95 — (See next page)

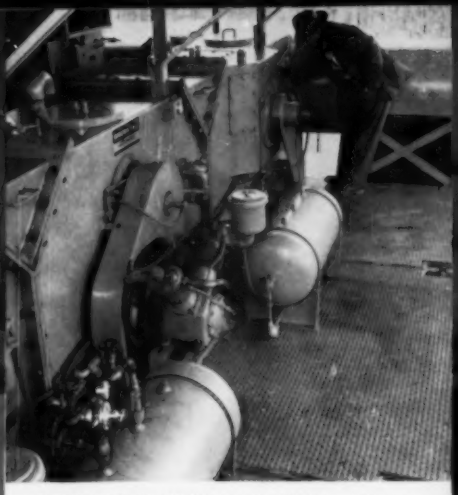
RUGGED IRON

Two-Fisted Tough

EASY DOES IT . . . when it's a Brewster control panel. Full air operation plus simplicity in design leaves the driller free to follow the crew as they make a connection.

BREWSTER

GOOD HOUSEKEEPING and good rig layout go hand in hand to make fast, safe and efficient operation on Jett Rigs.



HEAVY DUTY COMPOUND on the N-95 prevents wear on chain, bearings and engine couplings through positive alignment and rigidity.

SIMPLIFIED mud pump manifolding and clean layout are naturals with Brewster's dual in-line pump drive arrangement.

SCHEDULED MAINTENANCE means dependable operation. The crew here is subricating linkage on the big 46" hydromatic N-95 brakes.

JETT DRILLING COMPANY, INC.

RIG 110

One of 7 Brewster drawworks operated by Jett Drilling Company, Inc., of Shreveport, the N-95 on Rig 110 is now completing its 3rd 14,000-foot well. In all the Company is operating 12 rigs; three are leased and all others are Jett owned.

Jett Drilling's remarkable growth is firmly based on sound operating policy, good men and the finest available equipment. This is why the last two rigs purchased have been Brewster N-95's and why the rotary tables, swivels and blocks are all Brewster matched equipment.

BREWSTER N-95

THE BREWSTER COMPANY, INC.
Shreveport, Louisiana

NON-SKID, flat surface of the Brewster 27-inch oil-bath table provides safe footing for the crew.

TOOLPUSHER, E. M. RODGERS takes over controls for a "first hand" check out on rig performance.

SUPPLY HOUSES

Howard Supply Company • Apex Equipment Company • Bovaird Supply Company • Industrial Supply Company • Murray Brooks, Inc. • United Supply and Manufacturing Company • Export Sales: The Brewster Company • (HOMCO) Houston Oil Field Material Company, New York, N. Y., Houston, Texas; Mexico City, D. F.

1200 horsepower is available to the driller from these three LRZBU engines.

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West Coast Offshore Platform Starts Operations

The West Coast's first offshore platform has started operations with the first well to be drilled by the Standard-Humble combine on their Summerland lease. The lease, first tidelands section opened to private drilling by California, is located off Santa Barbara just north of Los Angeles. The rig location is two miles offshore in 100 ft of water. It is expected that some 25 wells will be drilled from this location.

Creole Tests New Floating Rig Mover

Creole Petroleum Corporation recently put into operation on a test basis a floating rig mover. The rig mover, in operation in Lake Maracaibo in Venezuela, makes it possible to move all of the equipment necessary for drilling a well from one site to the next, including the derrick.

Creole engineers, in collaboration with consulting engineers, conceived and designed the unit to simplify and streamline well drilling operations on the lake. The huge equipment will simplify to a large degree the drilling activities and will also decrease the number of derricks on the lake.

Electric Rigs To Increase

Electric power is increasing its share of the business of providing power for drilling and will eventually be as widely used as steam and the internal combustion engine. This forecast was made by W. P. Stephens and A. H. Candee in a paper entitled "Improved Power for the Oil Driller," presented at the recent petroleum industry conference sponsored by the American Institute of Electrical Engineers. The authors claim that the drilling industry has been skeptical of electric drives, but expect that as the use of electrical machinery becomes more general in the drilling industry, "the fear and distrust of things electrical will become entirely dissipated."

Swamp Buggy Rigged Up With Truck Chassis

In swampy areas, a simple means of transportation may be rigged up by replacing the wheels of a truck with metal drums which will increase the bearing surface sufficiently to support the truck in the swamp. The front wheels are made by using a band of flat iron to make a cylinder 4 ft in diameter. The existing wheel is used and a cone-shaped band is used to run between the wheel and the rim on the outside. The inside is a flat welded plate to give a strong support.

The back end is made by mounting another axle some distance in front of the existing axle and using a chain to drive the wheels. This gives a chance to reduce the velocity of the rear wheels and provides more power. The rear wheels are formed much the same as the front wheels, and cleats have been added to provide traction through the mud.

The Dope Bucket

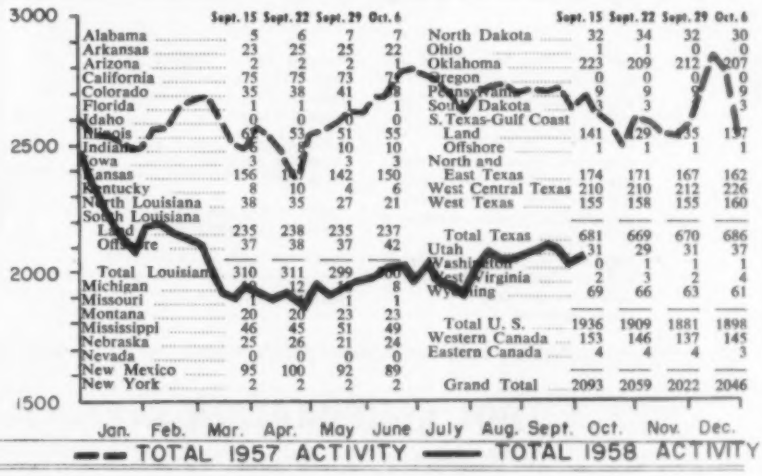
... Pan American International has awarded contracts to Loffland Brothers Drilling Company to drill in Argentina. Loffland is assembling five rigs to start the program which, under Pan Am's concession, is expected to include 50 wells. ... R. J. Maberry, formerly with Curtis & Lomax Drilling, has joined Denver Drilling Corporation as vice president. Offices of the company are in Odessa, Texas. ... Laughlin-Porter Drilling Company, of Midland, has a contract to drill a 13,000-ft wildcat on a 2,400,000-acre concession in the Ivory Coast of Africa. Work is for Plymouth Oil, Benedum-Trees, and a French company. ... Don E. Satterthwaite, independent of Wichita, has been elected president of the SeRoBee Drilling Company, Inc., and Della C. Nelson has been elected a director. The company operates in central and western Kansas.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	Sept. 15	Sept. 22	Sept. 29	Oct. 6
Alabama	5	6	7	7
Arkansas	23	25	25	22
Arizona	2	2	2	1
California	75	75	73	71
Colorado	35	38	41	38
Florida	1	1	1	1
Idaho	0	0	0	0
Illinois	55	53	51	55
Indiana	8	8	10	10
Iowa	3	3	3	3
Kansas	156	147	142	150
Kentucky	8	10	4	6
North Louisiana	38	35	27	21
South Louisiana				
Land	235	238	235	237
Offshore	37	38	37	42
Total Louisiana	310	311	299	300
Michigan	10	12	7	8
Missouri	1	1	1	1
Montana	20	20	23	23
Mississippi	46	45	51	49
Nebraska	25	26	21	24
Nevada	0	0	0	0
New Mexico	95	100	92	89
New York	2	2	2	2

	Sept. 15	Sept. 22	Sept. 29	Oct. 6
North Dakota	32	34	32	30
Ohio	1	1	0	0
Oklahoma	223	209	212	207
Oregon	0	0	0	0
Pennsylvania	9	9	9	9
South Dakota	3	3	3	3
S. Texas-Gulf Coast				
Land	141	129	135	137
Offshore	1	1	1	1
North and				
East Texas	174	171	167	162
West Central Texas	210	210	212	226
West Texas	155	158	155	160
Total Texas	681	669	670	686
Utah	31	29	31	37
Washington	0	1	1	1
West Virginia	2	3	2	4
Wyoming	69	66	63	61
Total U. S.	1936	1909	1881	1898
Western Canada	153	146	137	145
Eastern Canada	4	4	4	3
Grand Total	2093	2059	2022	2046



Humble's John Bell Heads Engineers Society for '59

2400 SPE-AIME members attend Houston meeting

At the second largest meeting ever put on by the Society of Petroleum Engineers of AIME... the group's 33rd annual fall meeting held in Houston, Texas, October 5-8, John S. Bell, area manager for Humble Oil & Refining Company, Los Angeles, California, was elected 1959 president. He succeeds Basil P. Kantzer, Union Oil Company of California.

Other officers elected include Wayne E. Glenn, production manager for Continental Oil Company, Houston, and M. B. Penn, Sunray Mid-Continent Oil Company, Tulsa, Oklahoma, new vice presidents. Members elected to the

Top officers for the coming year, shown here, include Wayne Glenn, Conoco, who will be SPE vice president; Howard Pyle, Monterey, president-elect of AIME, and John S. Bell, Humble, president-elect of SPE.

Announcing A Completely New Flow Control Valve

TYPE "A"

- For controlling flow rate of gas or liquids.
- All working parts (except cast steel body) manufactured from stainless steel.
- Plug type, proportioning, hardened valve with self-centering stainless steel seat provides a straight line graduated increase of flow rate.
- Simplicity of design provides easy dismantling and assembly with valve and seat easily replaced.
- Knurled handle offers micrometer adjustment calibrated in turns and tenths of turns.
- Locks in any position with Allen hex-head set screw in handle.
- Teflon sleeve packing gland requires no lubrication.
- Available with 1" through, 1" angle, 2" through or 2" angle 2000# WP cast steel body.

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board of directors were: C. R. Horn, Panhandle Eastern Pipe Line Company, Liberal, Kansas; John A. Rodgers, Gulf Oil Corporation, Lumberton, Mississippi; H. M. Krause, Jr., Humble Oil & Refining Company, Houston; and L. P. Whorton, Atlantic Refining Company, Dallas.

Sixty-three technical papers were presented during the three-day Houston meet during two simultaneous sessions running both morning and afternoon. The Gulf Coast Section of AIME, and largest petroleum section of the Society with over 1500 members, was host for the meeting. Rupert C. Craze, Humble Oil & Refining Company of Houston, is chairman of this section and I. W. Alcorn, vice president of Coastal Marine Drilling and Construction Corporation, Houston, served as honorary chairman.

"Fantastic pace of research" was the theme of president's talk. One of the highlights of the meet was an inspiring discussion of a difficult subject . . . research . . . by AIME president A. B. Kinzel, vice president in charge of research for Union Carbide Corporation, New York City. "Business must look at research," Kinzel stated, "as a route to increase earnings. Without that objective, it will flounder." The technological race between this country and Russia can only end in a "dead heat," he said, because the iron curtain of research becomes quite flimsy and it is difficult to hide new developments. Research will amplify this country's demand for energy in the future, and it is not likely that nuclear energy will ever replace energy requirements of petroleum or the fossil fuels.

Nearly 2400 men and approximately 1000 wives attended the annual fall meet. Thirty-two representatives from seven foreign countries and Alaska attended. Outside of Alaska, other countries represented include the Netherlands, Peru, Venezuela, Austria, Mexico, France, and Indonesia.

Oustanding awards presented during the meeting include the John Franklin Carll Award, presented to General Ernest O. Thompson of the Texas Railroad Commission for his contribution to petroleum engineering in the public acceptance of reservoir engineering principles in conservation regulation and practices. Co-recipients of the Cedric K. Ferguson Medal were Jim Douglas, Jr., P. M. Blair and R. J. Wagner for their outstanding paper, "Calculation of Linear Waterflood Behavior Including the Effects of Capillary Pressure" . . . the best technical paper of the year prepared by AIME members under 33 years of age.

★ ★ ★

Petroleum Consultants Add Data Processing Service

A new department of electronic data processing, which substantially broadens the company's services to the petroleum industry, has been announced by H. J. Gruy and Associates of Dallas, consulting petroleum and geological engineers.

Utilizing the IBM 650 stored program computer and the most recent advances in data processing techniques, Gruy has established a most complete general technical computing center to serve the petroleum industry.

Services range from maintenance of accounting records to engineering, including calculating of data for refining, production, geophysical and geological studies, reservoir analysis, production and reserve estimates, analysis of laboratory data, seismic studies, gravity measurements, evaluation of development programs and future reserves based on current production rates, taxes, refineries and gathering systems, gas and oil transmission problems and secondary recovery operations.

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In the field, Roper Series 3600 Pumps are used for such applications as circulating and recirculating, pulling from test tanks, and for general transfer work.

Widely recognized for dependability, Roper Series 3600 Pumps are designed to handle thick or thin oil at slow speeds. Available in 40 to 300 GPM sizes, pressures to 100 PSI, they are fitted with two equal size helical pumping gears, heavy duty, high-lead bronze bearings, adjustable relief valve; with packed box or mechanical seal. Specify Roper . . . job-proved in oil fields everywhere!

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1958 President J. U. Teague passes the gavel of leadership to President-elect Joe Zeppa.

At 18th annual meeting

JOE ZEPPA NAMED AAODC

Executive Vice President Mills

Joe Zeppa of Tyler, Texas, president of Delta Drilling Company, was chosen president of the American Association of Oilwell Drilling Contractors for 1959 at the 18th convention of the organization in Dallas, Texas, Oct. 1-3.

The membership also elected George P. Livermore, Livermore Drilling Company, Lubbock, Texas, as AAODC national vice president.

Other new officers are: Vice President for Cable Tools Ray Wiley, Ray Wiley Drilling Company, Carmi, Illinois; Vice President for West Texas and New Mexico H. Don Johnson, Carl B. King Drilling Company of Texas, Midland, Texas; Vice President for Gulf Coast Morris McDannald, Mac Drilling Company, Houston, Texas; Vice President for Central Mid-Continent Frank G. McClintock, Zephyr Drilling Corporation, Tulsa, Oklahoma; Vice President for Rocky Mountains F. M. Stevenson, Signal Drilling Company, Denver, Colorado; Vice President for California Wm. D. Tetsch, Terminal Drilling and Production Company, Los Angeles, California; Vice President for Illinois, Michigan, Indiana, and Kentucky Don Slape, Don Slape Drilling Company, Olney, Illinois; Vice President for Cretaceous and Tertiary Basins A. Earl White, Mustang Drilling Corporation, Tyler, Texas; Vice President for Well Servicing E. F. Fullen, Mallard Well Service, Lafayette, Louisiana; Vice President for North and West Central Texas M. G. Rowe, Rowan Drilling Company, Inc., Fort Worth, Texas; and Vice President for Offshore W. W. Hawkins, Win Hawkins Drilling Company, Lafayette, Louisiana.

Secretary-Treasurer is W. L. McClusky, M. J. Delaney Company, Dallas, Texas and Marion S. Church, Dallas, Texas will remain general counsel.

Presiding over this year's convention was J. U. Teague, Columbia Drilling Company, Houston, Texas. Teague is 1958 president of the organization.

Mills Retires

Brad Mills, executive vice president of the AAODC for the past 18 years, has elected to take early retirement effective as soon after January 1, 1959, as a successor may be chosen.

Mills started with the association in early 1941 and has retained headquarters in Dallas since that time.

The organization has grown from an original membership of 10 firms to

WE REDUCED THE GAS-FLUID RATIO
ON OUR NO. 1 WELL BY 6,900 CU. FT./BBL. —
AND INCREASED OIL PRODUCTION 20 PER CENT —
WHEN WE SWITCHED TO TYPE F OTIS RETRIEVABLE GAS LIFT VALVES.
THAT GAVE US A 75 PER CENT REDUCTION IN THE AMOUNT OF GAS REQUIRED TO PRODUCE THE WELL, PLUS A DIRECT SAVINGS IN GAS COMPRESSION COSTS PER BARREL OF OIL PRODUCED. WHAT'S MORE, WE DIDN'T HAVE TO RESPACE THE MANDRELS TO DO IT. YOU SEE, THE TYPE F HAS A RESILIENT MAIN VALVE ELEMENT LIKE THIS IN IT WHICH ACTS AS A VARIABLE ORIFICE. THIS GIVES US CONTROL OF INJECTION GAS AT THE SURFACE. THERE ARE NO CHOKES IN THE VALVE TO RESTRICT GAS FLOW. IN FACT, THE TYPE F HAS AN EXTRA LARGE GAS FLOW PORT AREA TO PASS A MAXIMUM AMOUNT OF GAS AT A MINIMUM PRESSURE, WHEN NECESSARY.
THIS IS HOW THE TYPE F WORKS. THE AREA ABOVE THE SLOTTED PORTS IS THE DOME PRESSURE AREA. PRESSURE IN THE DOME HOLDS THE MAIN VALVE ELEMENT CLOSED ACROSS THE SLOTS IN THE VALVE BODY. THE MAIN VALVE FLEXES TO ADMIT GAS WHEN PRESSURE IN THE ANNULUS EXCEEDS THE SET PRESSURE OF THE VALVE BY AS LITTLE AS ONE OR TWO POUNDS. INCIDENTALLY, BOTH THE DOME AREA AND THE PORT AREA IN THE TYPE F OTIS VALVE ARE EXTRA LARGE.

PRESIDENT

announces early retirement

Awards were made to Charles A. Norton by AAODC President Teague, and to William D. Tetsch by Don Slape, chairman of the national chapter activities committee. Norton received the President's Award and Tetsch was given the special award for outstanding service.

more than 950 member firms of all types during Mills' tenure of office. Mills will remain with the Association in an active advisory capacity.

1959 Objectives Listed

Attending the 18th annual convention were some 650 persons. The group heard papers on blowout control and developments in air and gas drilling. Contractors also heard of possibilities in Alaska and were told of new economic horizons for the industry by a leading economist.

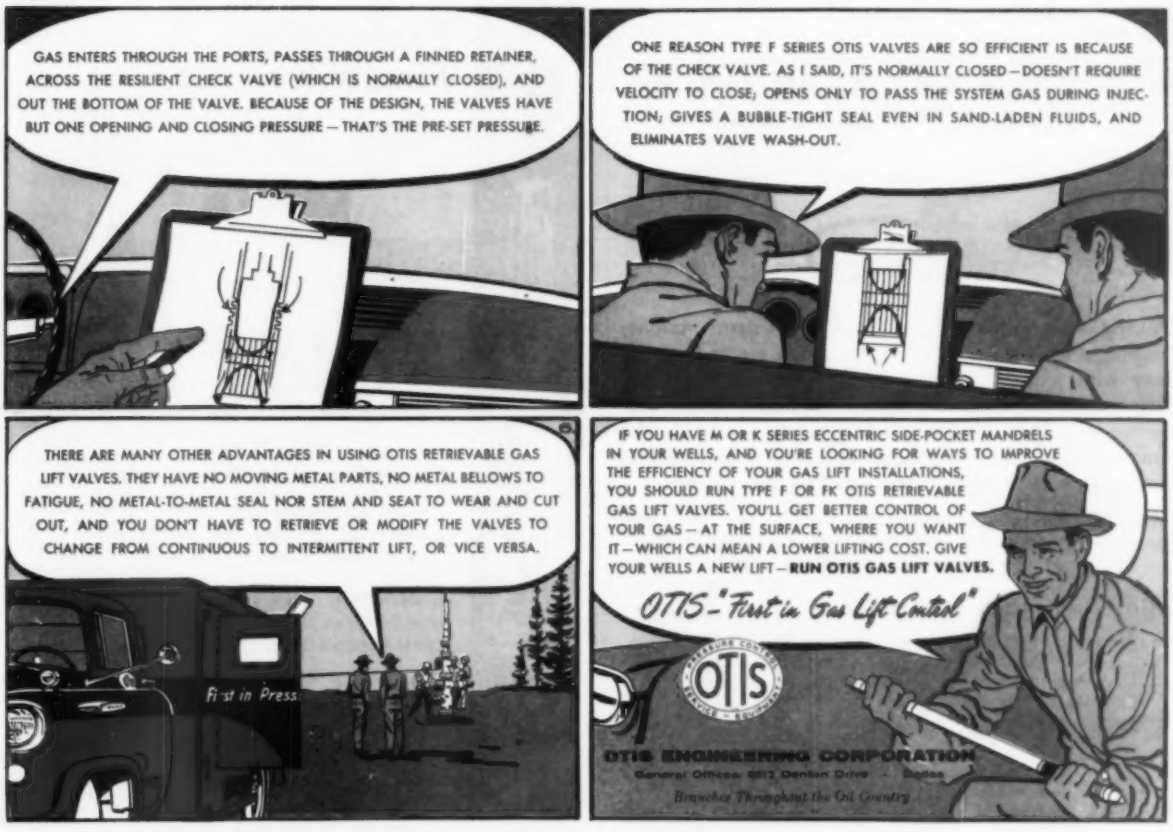
Joe Zeppa, the president-elect, outlined the objectives for the organization during the year to come. His ultimate aim would be to enlist all of the people engaged in drilling business in the AAODC, and would like to increase the already splendid spirit of cooperation among the members. Zeppa, whose Delta Drilling Company and affiliates operate 55 rigs in the U.S., Venezuela, Italy, Sicily and North Africa, predicted that the low rate of rig activity would continue. The industry is operating at about 60 percent of full capacity, and in terms of rig activity, 25 percent down from 1956.

Achievement Awards

Achievement awards were presented to two outstanding chapters. Charles A. Norton, Norton Drilling Company, New Orleans, Louisiana, received the annual President's Award "for outstanding leadership as chairman of the New Orleans Chapter for 1958."

Wm. D. Tetsch, Terminal Drilling and Production Company, Los Angeles, California, received a special award "for outstanding service as Chairman of the California Chapter for 1958."

The awards were presented at the Thursday luncheon by J. U. Teague and Don Slape, Don Slape Drilling Company, Olney, Illinois, chairman of the national chapter activities committee. ★ ★ ★


GAS ENTERS THROUGH THE PORTS, PASSES THROUGH A FINNED RETAINER, ACROSS THE RESILIENT CHECK VALVE (WHICH IS NORMALLY CLOSED), AND OUT THE BOTTOM OF THE VALVE. BECAUSE OF THE DESIGN, THE VALVES HAVE BUT ONE OPENING AND CLOSING PRESSURE — THAT'S THE PRE-SET PRESSURE.
ONE REASON TYPE F SERIES OTIS VALVES ARE SO EFFICIENT IS BECAUSE OF THE CHECK VALVE. AS I SAID, IT'S NORMALLY CLOSED — DOESN'T REQUIRE VELOCITY TO CLOSE; OPENS ONLY TO PASS THE SYSTEM GAS DURING INJECTION; GIVES A BUBBLE-TIGHT SEAL EVEN IN SAND-LADEN FLUIDS, AND ELIMINATES VALVE WASH-OUT.
THERE ARE MANY OTHER ADVANTAGES IN USING OTIS RETRIEVABLE GAS LIFT VALVES. THEY HAVE NO MOVING METAL PARTS, NO METAL BELLOWS TO FATIGUE, NO METAL-TO-METAL SEAL NOR STEM AND SEAT TO WEAR AND CUT OUT, AND YOU DON'T HAVE TO RETRIEVE OR MODIFY THE VALVES TO CHANGE FROM CONTINUOUS TO INTERMITTENT LIFT, OR VICE VERSA.
First in Press
IF YOU HAVE M OR K SERIES ECCENTRIC SIDE-POCKET MANDRELS IN YOUR WELLS, AND YOU'RE LOOKING FOR WAYS TO IMPROVE THE EFFICIENCY OF YOUR GAS LIFT INSTALLATIONS, YOU SHOULD RUN TYPE F OR FK OTIS RETRIEVABLE GAS LIFT VALVES. YOU'LL GET BETTER CONTROL OF YOUR GAS — AT THE SURFACE, WHERE YOU WANT IT — WHICH CAN MEAN A LOWER LIFTING COST. GIVE YOUR WELLS A NEW LIFT — RUN OTIS GAS LIFT VALVES.
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Versatile Emergency Jack Lifts 15 Tons at 4 Lifting Points

Lifting, skidding and leveling rigs; pushing, pulling and positioning machinery; supporting pipe and equipment are just a few of the oil field jobs done easily with the versatile Simplex No. 310A Emergency Jack. It handles full 15-ton capacity at four points; has 13" lift with minimum toe height of 2¼"; tilts on base for use at any angle.

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Books to Read

▸ **Corrosion of Oil and Gas Well Equipment,** *published by the American Petroleum Institute, Division of Production, 300 Corrigan Tower Building, Dallas 1, Texas. Pages, 96. Price $2.50.*

This new training publication, developed jointly by the API and the National Association of Corrosion Engineers, was prepared especially for field operations personnel. It covers the general aspects of corrosion, sweet corrosion, sour corrosion, oxygen corrosion and electro-chemical corrosion. Methods of evaluation and control measures are described in detail. The book seeks to improve operators' ability to recognize and report early indications of corrosion, and to effect a quick, economical solution to this expensive problem.

▸ **Standard Practices for Stationary Diesel and Gas Engines,** *fifth edition, published by the Diesel Engine Manufacturers Association, 2000 K Street NW, Washington 6, D. C. Pages, 220. Price, $5.*

For the first time since the manual was initially published in 1930, the title and subject matter has been substantially changed. The fifth edition of the DEMA Standard Practices now includes gas engines, as well as diesel and dual fuel engines. Its 20 chapters have been revised, modified and updated to include latest ASTM specifications on oils and American Standards and electrical standards of NEMA. The chapter on governors has been altered according to recent modifications specified by a joint AIEE-ASME committee and adopted by these two societies.

NOTICE

An article entitled "Maximum Horsepower Where It Counts" appeared in the October 1958 issue of *The Petroleum Engineer*. We regret that the source of this article was not properly acknowledged. The article was adapted from a paper entitled "How to Get the Most Hydraulic Power at the Bottom of the Drill String in Rotary Drilling," presented by the author, Ross W. Colebrook, at the ASME Petroleum Conference, September 21-24, Denver, Colorado.

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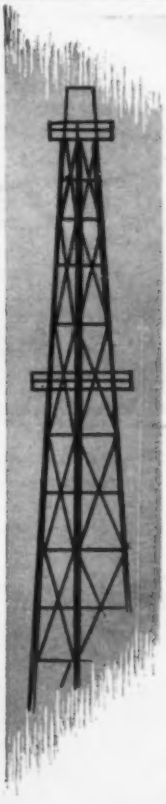
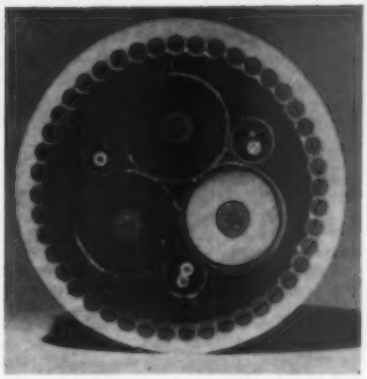


ELECTRIC CABLE LAID TO OFFSHORE PLATFORM



Cross section of cable which will provide power up to 4500 hp for Stancal's drilling platform located 2½ miles offshore near Santa Barbara, California.

ONE OF THE LONGEST lengths of plastic insulated submarine power cable ever manufactured was recently laid from land to the giant drilling platform which Standard Oil of California, Western Operations, Inc., and Humble Oil and Refining Company will use to test their state offshore oil lease near Summerland, California. Insulated and sheathed with polyethylene, the 16,500-v, three conductor cable is capable of carrying more than 3500 KVA or more than 4500 hp.

The cable is made up of three No. 2 stranded conductors over which there is a layer of semi-conducting tape. The individual conductors are covered with a wall of Okolene (polyethylene), each in a different color for coding and identification. Each insulated conductor is then covered with a layer of semi-conducting Okoprene and shielded with untinned copper tape. The three insulated and shielded conductors are cabled together with preservative-treated jute with one pair of No. 16 Okolene insulated wires in each interstice. Over this is a cushioning layer of jute and No. 8 BWG galvanized steel wire armor. The entire construction is jacketed with a wall of yellow Okoprene.

The three pairs of small cables in the interstices are to be used for communications, the transmission of alarm functions from the platform to shore, and for remote control after the wells begin to produce.

A barge with the cable reel on its stern was anchored some 400 ft from the shore and was held in place by 2 sea-going tugs. A line was fired to the barge and a tractor on shore pulled the starting end of the cable to the beach. It was necessary to run the cable some 60 ft up a 45-deg cliff. This run was ditched to a depth of approximately 4 ft.

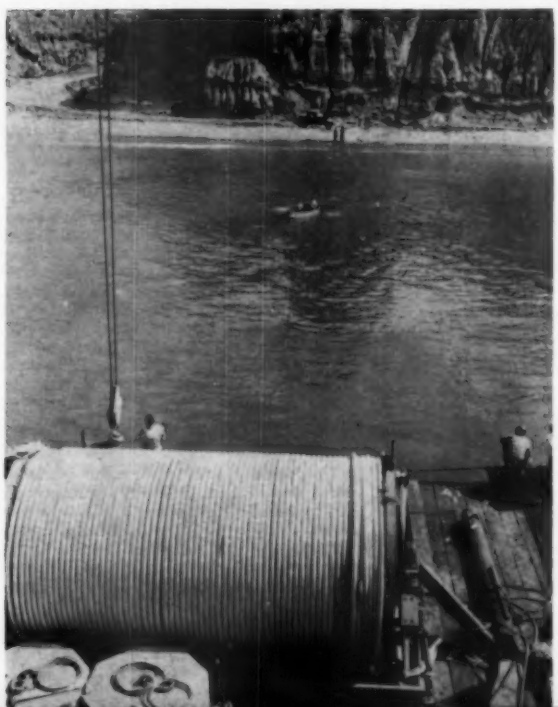
After the cable was securely anchored at the base of the cliff, it was inserted in a trenching plow. The plow was drawn to the barge from the shore by means of a winch and, as it traveled along the bottom of the ocean, it buried the cable to a depth of approximately 3 ft. The plow itself weighed 8 tons. In order to avoid damage to the cable during the laying process, a diver worked under the water to guide the cable. The plowing action took approximately 2 hours.

The cable then took a course of a wide sweeping semi-circle to the drilling platform. This was done in order to keep the cable separated from the pumplines and pipes which will be installed to transport oil from the wells to shore.

The entire laying process took just over an hour. About midway between the shore and the platform there was a heavy surface kelp bed. The cable was laid on top of the kelp and immediately sank to the bottom.

At the drilling rig itself, a conduit pipe was run from the platform to the ocean floor. The pipe has a 16-ft scoop at its bottom end. The cable was drawn into this scoop which will prevent friction and wear at the conduit end and was then drawn to the deck of the platform.

The electric cable, manufactured by The Okonite Company, Passaic, New Jersey, will supply power to the platform which has been designed to drill up to 25 wells from the same site, two at a time. The platform is located in water 100 ft deep and stands 50 ft above the ocean surface. ★ ★ ★



◆ Plastic-insulated cable was drawn to shore from this huge reel. From the shore, the cable was run some 60 ft up the 45-deg cliff through a 4-ft ditch.

◆ This 8-ton plow buried the length of cable from the shore to the barge to a depth of approximately 3 ft.

RUNNING TOUR with MEN in the INDUSTRY

▸ **W. Joseph Straus** has been elected to the board of directors of Britalta Petroleums, Ltd., Canadian independent oil company of Calgary, Alberta, Canada. Straus is economist and a financial adviser to William Rosenwald, chairman of American Securities Corporation, is also a director of that investment banking firm, and of American Machine and Metals, Inc., Haveg Industries, Inc., Texas Butadiene & Chemical Corp., and a number of other companies.

▸ **C. A. Sullins** has been named successor to **C. A. McDowell,** who has retired as general superintendent of drilling and production for Union Producing Company. Sullins has been district drilling and production superintendent in Beeville, Texas, for the past ten years. Succeeding Sullins is **W. B. Phillips,** who has been district petroleum engineer there. His former post is taken by **N. A. Prince,** who was field drilling and production superintendent at Houma, La.

▸ **T. T. Conger** has been appointed general manager producing and exploration for Pakistan, Standard Vacuum Oil Company. He was formerly general manager of producing for India. **R. G. Prough,** formerly resident manager of exploration, has succeeded Conger. **J. F. Mason** has been appointed exploration manager for Pakistan. He had been resident manager of producing in Karachi.

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▸ **Charles J. Bryce** has assumed charge of the Venezuela headquarters of Brown Drilling Company. He was recently superintendent with McFarland Drilling, of Midland, Texas.

C. J. Bryce

P. E. Chaney

▸ **Preston E. Chaney** has been promoted to associate director of production research and development for Sun Oil Company. **Fred M. Mayes** succeeds Chaney as assistant director, and **Jack W. Jones** replaces Mayes as section head for electrical logging and instrumentation.

Named to positions in the company's Latin America division, at offices in Caracas, Venezuela, were: **P. W. McFarland,** formerly division chief geologist, to exploration manager; **L. C. Smith,** named division chief geologist. Formerly Smith was assistant chief geologist; **L. M. Rucker,** from district paleontologist to regional paleontologist; **J. A. Waller,** district geophysicist, to division geophysicist; **R. C. Weart,** research geologist, was formerly with Sun's Physical Research Laboratories in Dallas, Texas. **C. E. Lehecka,** former district geologist, named regional geologist at Caracas.

Appointed district geologists were **J. D. Taylor** (Maracaibo district) and **D. W. Simmons** (Eastern Venezuela district). Both men formerly held the position of geologist. In Colombian Sun Oil Company, **E. C. Robinson** has been promoted from geologist to district geologist at Bogota.

▸ **M. L. Hagan** has been appointed as division manager of the Tulsa division of American Climax Petroleum Corporation. He succeeds **L. L. Brundred,** who organized this division and has been its manager since 1954. Hagan was formerly production superintendent for ACPC.

▸ **S. A. Hovanessian** recently received a PhD in engineering at UCLA and has accepted a position in oil field producing research at the La Habra Laboratory of California Research Corporation.

W. T. Holser recently with the Institute of Geophysics, has accepted a research position in the geology division of California Research.

▸ **Ralph P. Latimer** has been named assistant to the manager of production and exploration for the Lion Oil Company division of Monsanto Chemical Company. Latimer, has been administrative assistant to Lion President **T. M. Martin** since 1952.

▸ **Dr. E. R. Brownscombe** has been appointed senior research associate in the crude oil production division of The Atlantic Refining Company and **Dr. R. G. Simard** as research associate in the basic research division at Philadelphia.

▸ **L. Russell Marks** was elected executive vice president of Murphy Corporation. He has been vice president—finance and service since 1955. **J. A. O'Conner Jr.,** was elected vice president. He has been secretary and general counsel of Murphy Corporation since 1954.

▸ **J. W. W. Whitney Jr.** has been promoted to the position of general production superintendent for White Eagle Oil Company. He was formerly chief production engineer.

J. W. W. Whitney, Jr. R. H. Smith

▸ **Roy H. Smith** has been appointed chief petroleum engineer for Pan American International Oil Company and has been assigned to the firm's New York office. Smith was formerly chief production engineer for Pan American Petroleum Corporation at its Tulsa, Oklahoma general office.

▸ **R. N. Walker,** district production superintendent for Tennessee Gas Transmission Company, has been transferred to the new Durango district with the same duties. **R. M. Stephens,** formerly chief petroleum engineer, will replace Walker, and **H. E. Rowe Jr.,** Mid-Continent division petroleum engineer, will become chief petroleum engineer. **P. H. Lenhart,** Great Bend district petroleum engineer, will replace Rowe, and **L. W. Rogers,** petroleum engineer, Oklahoma City district, will replace Lenhart. **J. J. Lacey,** petroleum engineer in the Wichita Falls district, will be district petroleum engineer at Durango.

D. P. Dampf will move from the Hobbs district to the new Shreveport district as district production superintendent. **Dewitt Coffey,** Oklahoma City district production foreman, is to replace Dampf as district superintendent. **H. O. Stallings,** senior petroleum engineer, will become district petroleum engineer at Shreveport. **J. F. Mayfield,** Gulf Coast division petroleum engineer, will transfer to the Houston office as equipment engineer. **W. T. Wells Jr.,** Wichita Falls district petroleum engineer, will replace Mayfield, and **E. L. Freund,** petroleum engineer in the Houston office, is to assume Wells' former duties.

Donald I. Gahagan, staff geologist in the Houston office, to district exploration manager, Bellaire district. **Marty A. O'Brien,** Corpus Christi district landman, to district exploration manager in the new Shreveport district. The new district exploration manager, Wichita Falls district, will be **Donald L. Hellar,** formerly district manager in the Wichita, Kansas district.

N. B. Venus, district exploration manager at Salt Lake City, will be transferred to the new Jackson, Mississippi district. **R. B. Ross,** district geologist, will transfer from the Bellaire district to Jackson. **W. H. Medary,** Roswell district geologist, will move up to district exploration manager at Midland. **Robert M. Grace,** who will be district geologist at Midland, will transfer from the Salt Lake City district.

▸ **Charles F. Sarratt** has been appointed as vice president and member of the board of directors of Chris Well Servicing Company. Sarratt has been division salesman for Christensen Diamond Products.

J. D. Giles, district landman in the Oklahoma City district, will become district exploration manager there. **Beryl D. Carey,** Casper district, will be promoted from geologist, senior, to district geologist. **Claude B. Kirby Jr.,** district geologist, will move from the Wichita district to the Durango district.

▸ **W. R. Berry,** widely-known petroleum industry equipment design engineer, has joined Philip L. McLaughlin and Associates, Dallas, Texas. Barry's most recent oil field innovation is a lightweight, V-type pump for drilling rigs.

▸ **S. P. Kent** has been elected vice president and manager of operations for Paria Operations, Inc. Kent was superintendent of drilling and production for Texaco Exploration Company.

▸ **W. E. Boyd** has been appointed district superintendent for The British-American Oil Producing Company's southern district, replacing **Gordon J. Buckle.** Before assuming his new post with British-American, Boyd was division drilling engineer, Houston production division, Gulf Oil Corporation.

▸ **Royce K. Baker** has been named district manager of Findley Engineering Service Company's newly opened MacAllen, Texas office. He joined FESCO in 1952.

▸ **Mortimer Squires** has resigned as assistant general superintendent of drilling and production for Natural Oil & Gas Company and joined Rodgers, Seglund and Shaw Associates. He will handle drilling and production engineering problems and field operating matters.

▸ **William D. Blankenship,** formerly geologist with Shell Oil Company at Denver, Colorado, has joined Wm. Ross Cabeen & Associates as geologist in Cabeen's Manila office.**Cornelius K. (Kim) Ham,** district geologist for Cabeen at Los Angeles, has ben transferred to the company's office at Lima, Peru.

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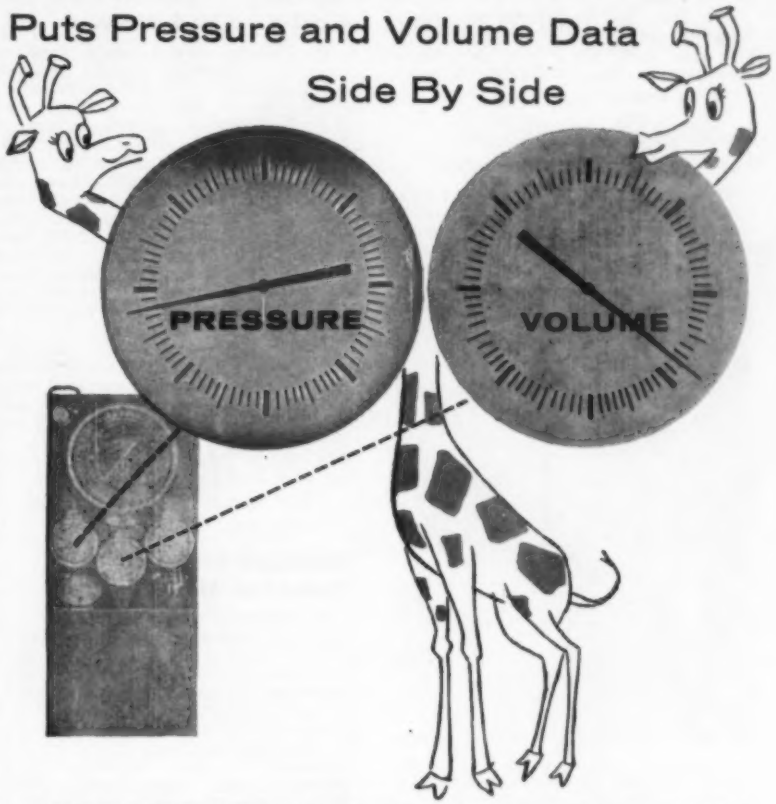

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It's New

Drilling – Producing Equipment

Full-Flow Drill Pipe Float Valve

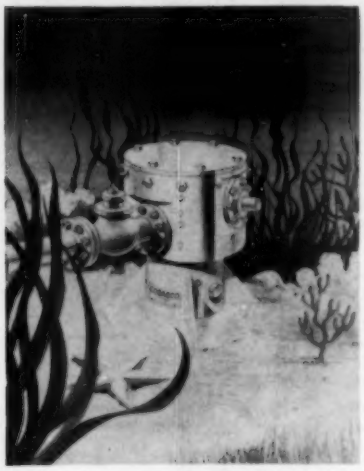
Baker Oil Tools has introduced a new full-flow drill pipe float valve. Use of a special-design flapper valve in the float valve eliminates diversion of the circulated drilling fluid against the bore of the drill collar, thus protecting the drill collar and prolonging the life of the valve itself. Vibration dampeners also extend the life of the valve. The valve closes immediately when circulation is stopped and opens immediately when the first joint is raised.

The valve can be installed either in a bored-out drill collar or in a Baker drill pipe float body which then serves as a tool joint sub. *Baker Oil Tools, Inc.*

Circle number (1) on reply card.

Stainless Steel Wellhead For Submerged Installation

Development of a 1-piece unitized wellhead made entirely of corrosion-resistant stainless steel for offshore drilling applications has been announced by Cosasco Division. The new wellhead is designed



for installation on the ocean floor or for use in tidelands locations where splash-area protection is necessary.

Body of the wellhead is hammer-forged from one billet of stainless steel. Design of the wellhead eliminates valves from flow lines, reduces wellhead dimensions to a minimum, and permits fast access to well tubing and annulus at any time. The units are available for all casing programs and all API series and can be designed to handle working pressure to 30,000 psi and higher. *Casasco Division of Perfect Circle Corporation.*

Circle number (2) on reply card.

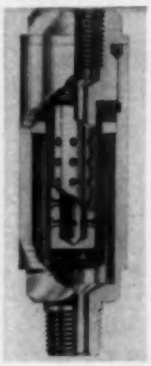
Chemical Inhibits Scale Formation

Scale deposits can be minimized with Halliburton's new Scalechek. The service uses a scale-checking compound to inhibit scale crystallization in and on formation faces and tubular goods. The compound is a sodium calcium polyphosphate with retarded reversion to orthophosphate, lesser tendency to reprecipitation and temperature stability. Placed in the formation in combination with fracturing sand or with oil alone, the compound conditions the water in and around the pay zone to check crystal growth. *Halliburton Oil Well Cementing Company.*

Circle number (3) on reply card.

Auxiliary Check Valve

The Macco normal closed auxiliary check is a 5000-psi working pressure valve which is manufactured with ½-in. pipe thread connections. It consists of a resilient hycar sleeve built around a ported mandrel tube and enclosed by a stainless steel or monel valve body. When back pressure is applied, the hycar sleeve seals off the ports in the mandrel tube, preventing any possible backflow.



This valve was designed primarily for use in dual-completed wells. It prevents communication between zones where mud, sand, or other debris may be present in the annulus. *Macco Oil Tool Company, Inc.*

Circle number (4) on reply card.

Packaged Test and Production Unit

A new Odex Engineering unit measures total fluid production of a lease, plus oil, gas, and water for each well in sequence. It is designed for automatic operation, controlled at the lease or at a remote central office to program and monitor production and receive instant warnings of off-normal conditions. The unit is pre-engineered to lease requirements and prefabricated in 3 skid-mounted sections: Metering separator, manifold, and metering free-water knockout. *Odex Engineering Company.*

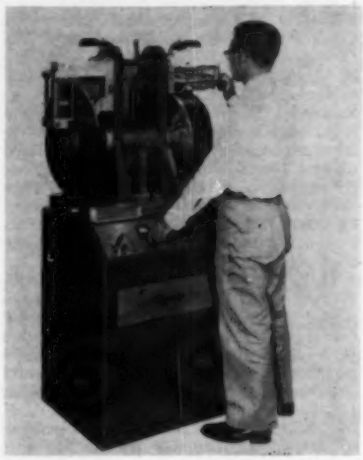
Circle number (5) on reply card.

One-Bolt Emergency Pipe Clamp

M. B. Skinner Company has introduced the Junior emergency pipe clamp, made up in a single-bolt width instead of 2-bolt width, and only 2⅞-in. wide. It is made of malleable iron and has a full length hinge alone one side and a single oversized plated bolt on the other. The pressure-equalizing gasket is cemented in. *M. B. Skinner Company.*

Circle number (6) on reply card.

Transcriber Standardizes Seismic Magnetic Tapes



A new seismic magnetic media transcriber, called Omnitape, has been developed by Hale Instruments. The instrument is designed to standardize all types of magnetic tapes and discs now in popular use by transcribing the seismic data from one major tape or disc to any other major tape or disc without loss of record fidelity. This is accomplished with a single playback head transcribing one trace at a time to a single recording head, with the heads automatically moving over to the next trace on the respective tapes. The unit is easily operated by semi-skilled personnel and requires less than 3 minutes for transcription of any pre-recorded tape. *Hale Instruments, Inc.*

Circle number (7) on reply card.

Knuckle-Joint Tubing Swab

Guiberson has announced a new knuckle-joint tubing swab. Design is such that cups may be changed without tools in only 10 seconds, on the floor derrick. The swab may be converted to a multi-cup swab by merely adding an upper mandrel and cup for each extra cup desired. Swivel-knuckle action of the ball and socket joints allows a fast fall, even in crooked tubing. Cups are free to swivel and float on the mandrel, serving double duty as cups and as valves. Available from stock in 2 or 2½-in. sizes. *The Guiberson Corporation, one of the Dresser Industries.*

Circle number (8) on reply card.

Improved Rubber Guide Cage

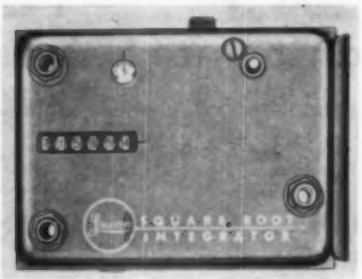
guide cage, which provides complete pro-

An improvement in the Martin rubber tection for the cage in situations where extreme or unusual ball impact might occur, has been announced by the manufacturer. Protection is accomplished in all open type cages by leaving a cross bar of the cage metal above the ball to serve as a back-stop for the resilient ball stop. The same protection is provided in the closed type cages, when needed, by optional ball guides having metal inserts in their upper portion. *John N. Martin, Manufacturer.*

Circle number (9) on reply card.

Automatic Fluid Flow Integrator

Designed to meet instrumental system needs of flow measurement, a new and compact square-root integrator by Librascope provides a continuous means of automatically totaling flow. Designed for use in standard flowmeters that utilize the



output of conventional sensing elements, the integrator has a wide range of applications, including that of pressure correctors on positive displacement meters. The unit can also be adapted to miniature strip chart flow recorders, forming an electromechanical integrator.

The unit utilizes a double disk and ball integrating mechanism. Linearity of the square-root integrator is 0.25 percent of full scale, achieved with a repeatability of 0.05 percent of full scale. Operating temperature range of the instrument is —40 to + 150 F. A pulse switch provides information to remote counters, telemetering or data handling systems. *Librascope, Inc.*

Circle number (10) on reply card.

Lead Base Thread Lubricant

Mr. 'B is the name of a new tool joint compound recently introduced by I. H. Grancell Company, manufacturers of the 'Bestolife #270 compound. Mr. 'B is a lead base thread lubricant designed specifically for tool joints. It prevents galling and seizing and is strongly resistant to corrosive action. *I. H. Grancell Company.*

Circle number (11) on reply card.

Improved Junk Mills

The Servco line of junk mills has been improved by the addition of 4 wear strips on the body of the tools. This feature prevents damage to the casing during the milling operation. Cutting blades have been provided with heavier webs of hardfacing material consisting of chunks of carbide suspended in a resilient matrix. *Servco.*

Circle number (12) on reply card.

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Just Slide Them On and Drive Slips Flush with Casing.

Also use B and W Thread-Lock Cages and B and W Thread-Lock Cement to eliminate welding on bottom joints to prevent unscrewing as drilling continues.

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New Equipment

Long-Tooth Bit for Soft Formations

Oil Tool Manufacturing has developed a new bit with long teeth which deliver maximum penetration in such low compressive-strength strata as soft, shales, clays, red beds, and salt. To gain a tearing, gouging action without heavy weights, cones are offset 6 deg from the apex. Bits are heat treated to insure uniformity, reduce distortion and deliver bright scale-free finish. It is available in sizes ranging from 4¼ to 7⅞ in. *Oil Tool Manufacturing Company, Inc.*

Circle number (13) on reply card.

Steel Buildings Replace Utility Shack

Childers Manufacturing has announced a line of small all-purpose buildings completely new in small steel structures. The unit is a pre-cut, pre-punched building with sheet steel roofing and siding of

"step-down" design. The models are highly portable and come in 2 widths — 10 and 20 ft — and lengths of 6 ft or multiples thereof. Every part, including framing, is galvanized with a full 1¼-ounce coating of zinc per sq ft. Windows and doors can be located wherever needed and in the quantity needed. *Childers Manufacturing Company.*

Circle number (14) on reply card.

Packer Retriever Gives One-Trip Recovery

Bowen ITCO has added a new packer retriever to its line of tools. The retriever is designed for one-trip recovery. It will pass through the bore of the packer in catching position and provides protection against loss of the packer during milling operations. The retriever will pull the packer after it has been sufficiently milled over, and can be released from the packer in the hole if necessary, and then be reset to catching position. *Bowen ITCO, Inc.*

Circle number (15) on reply card.

High-Pressure Relief Valve

A new snap-action, high-pressure relief valve, Model 117, for protective use on repressuring pumps, hydraulic power service, hydraulic pumping units, hydrostatic test systems, and other pressure applications is available from Kinzbach Tool. A variety of pressure and capacity relationships are available with basic components common to several assemblies. The valve is available in ¼ NPT to ¾ NPT sizes. *Kinzbach Tool Company, Inc.*

Circle number (16) on reply card.

Hard pumping, or corrosive or abrasive fluids, often result in frequent, expensive pulling jobs due to valve failures. If you are having this problem, the solution lies in genuine DuMore Balls and Seats. DuMore, a special composition of chromium, cobalt, and tungsten, will take any kind of punishment because of its exceptional resistance to impact and pressure. Every DuMore Ball and Seat is manufactured to exact A.P.I. specifications. Each ball is precision ground to a sphericity of .0001". Each seat is individually ground and mated to its ball, vacuum tested, and individually packaged to assure perfectly-matched sets. Ask your supply store about DuMore. They'll tell you it's the best ball and seat you can run.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

The NEW REDA "450" SERIES PUMPS

provide more oil per dollar invested

- 250-600 B.P.D.
- 900-4,400 Ft. Lift
- For 5½" or larger Casing Sizes

The new REDA "450" Series Pumps will REDUCE your lifting costs, and provide ECONOMICAL, DEPENDABLE performance.

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LARGER PUMP SIZES AVAILABLE

SIGN OF QUALITY OILWELL REDA PUMPS

REDA PUMP COMPANY
BARTLESVILLE, OKLAHOMA
Manufacturers of Submergible Electric Motors and Pumps for Over 35 Years

Drilling-Producing Literature

Production Equipment Catalog

Catalog 58G, published by Rolo, presents useful information on the company's line of oil meters, standard and high capacity metering separators, automatic custody transfer units, calcium chloride gas dehydrators, and other products. *Rolo Manufacturing Company.*

Circle number (17) on reply card.

Resistivity Logs

A brochure has been prepared outlining the work done during the last few years with the Guyod Analogue Computer for six major oil companies. The brochure reviews over 7000 resistivity curves recorded with normals, laterals, the limestone device, a guard-electrode, and various laterologs. The curves supply basic data not before available for the interpretation of electric logs. *Hubert Guyod.*

Circle number (18) on reply card.

Screen Pipe Brochure

A new 8-page catalog describing screen pipe for oil, gas, and water wells is available from Emsco Screen Pipe Company. The catalog includes slotted screen pipe, vertical-slotted and drilled-hole wire-wrapped screen, ribbed-type wire-wrapped screen, and prepacked gravel-pack screen, together with specifications of various types. *Emsco Screen Pipe Company.*

Circle number (19) on reply card.

Sucker Rod Brochure

A new 4-page brochure containing manufacture comparisons of mechanical and chemical analyses for all makes of sucker rods is available from Axelson. The brochure includes the new specifications released by various sucker rod manufacturers. Categories include carbon manganese, 1¾-percent nickel, high-strength and miscellaneous rod comparisons. A technical description of Axelson's 59, 60, 77, and 79 rods is included. *Axelson Manufacturing Company.*

Circle number (20) on reply card.

Four Corners Area Map

The oil and gas fields of the Four Corners Area are outlined on a 3-color map of the area available from *The Petroleum Engineer.* Also shown are geologic structures, oil and gas pipelines, refineries, gasoline plants, and oil shale and gilsonite refineries. A tabulation of the principal oil and gas producing zones is included. *The Petroleum Engineer.*

Circle number (21) on reply card.

Tool Joints for Light Weight Drill Pipe

Reed Roller Bit has prepared a folder describing the Reed Wide Open tool joints for light weight drill pipe, available in either Super-Shrink Grip or Flash Welded. The folder includes complete dimensional tabulations of both types of joints for external upset light weight drill pipe. *Reed Roller Bit Company.*

Circle number (22) on reply card.

LACT Equipment Data

As an aid to evaluating and planning lease automatic custody transfer installations, Ralph N. Brodie Company has assembled a technical data folder. The folder includes specially prepared schematic drawings of complete LACT metering units, and various bulletins describing Brodie positive displacement meters, strainers, automatic control valves, automatic temperature compensator with full range gravity selector, air eliminators, and other specialized equipment. *Ralph N. Brodie Company.*

Circle number (23) on reply card.

Foaming Agents for Air-Gas Drilling

How to control water influx encountered during air drilling is the subject of a new bulletin issued by Aquaness Department, Atlas Powder. Describing the use of Afrox foaming agents, the bulletin embodies experience gained on 200-odd wells drilled during the past year with air or gas.

The bulletin discusses typical make-up and injection methods, techniques of use under common wet-hole conditions, and also describes methods for controlling bit and drill string corrosion. *Aquaness Department, Atlas Powder Company.*

Circle number (24) on reply card.

Wire Rope Data and Tables

A reference manual of data, tables, and information most frequently needed by the buyer and user of wire rope has been prepared by the E. H. Edwards Company. Designed to help solve common wire rope problems for the man who is working with wire rope in the field, the manual includes sections explaining how wire rope is made, how to select the right rope, how to use a wire rope, and how to splice wire rope. *E. H. Edwards Company.*

Circle number (25) on reply card.

Map of West Texas and Southeast New Mexico

A 3-color map of the Permian Basin of West Texas and Southeast New Mexico is available from *The Petroleum Engineer.* The map shows the major geologic structures of the area and outlines the major oil and gas fields. Also included are locations of refineries, gasoline plants, and carbon black plants. *The Petroleum Engineer.*

Circle number (26) on reply card.

Monel-Lined Tubular Goods

A folder prepared by Gray Tool Company explains the company's development of a process for installing a seamless tubular liner of Monel nickel-copper alloy or pure nickel inside seamless steel pipe. The folder illustrates the threads, seals, and torque shoulder of the pipe and includes specifications of Type "B" tubing, available in sizes from 2⅜ to 3½ in. *Gray Tool Company.*

Circle number (27) on reply card.

New Literature

Aluminum Weldor's Training Manual

Instructional information designed to train and qualify individuals in welding aluminum by the inert gas process is presented in Kaiser Aluminum Weldor's Training Manual. First section in the 144-page book discusses essential factors about both tungsten-inert-gas and metal-inert-gas welding techniques. Second and third sections offer step-by-step exercises. *Kaiser Aluminum & Chemical Sales, Inc.*

Circle number (28) on reply card.

Fibercast Bulletin

Fibercast Company has released a newly published bulletin on Fibercast chemical and line pipe, tubing, and fittings. A complete engineering data and general information booklet in color, its 16 pages cover such subjects as: What it is, production quality control, pipe strengths, engineering data and charts, chemical resistance, specifications, installation procedures, and applications. *Fibercast Company.*

Circle number (29) on reply card.

Generator Driven by Auto, Truck, or Tractor

Forney Generators has issued a brochure describing the company's new on-the-spot power generator. The 110-120 v, 2000 w, a-c generator mounts on a car, truck, or tractor motor to provide power for as many as four ½-in. electric drills at one time, or for other hand tools. The unit can also be used as a portable lighting plant. *Forney Generators, Inc.*

Circle number (30) on reply card.

Tank Weighing Systems

A bulletin covering Emery hydraulic tank weighing systems has been published. The catalog shows equipment available for use with load cells in providing indication, recording, printing, and controlling in tank weighing installations. The new bulletin describes the operation of the load cells and the transducing elements used with the various cells. *The A. H. Emery Company.*

Circle number (31) on reply card.

Steel-Hard Plastic Sealer

A new bulletin from Devcon Corporation describes company products for emergency and maintenance repairs. One product, Plastic Steel, hardens to steel-like strength 2 hr after the addition of a hardening agent. It bonds steel, bronze, wood, iron, aluminum, glass, and many other materials to themselves or each other without application of heat or pressure. *Devcon Corporation.*

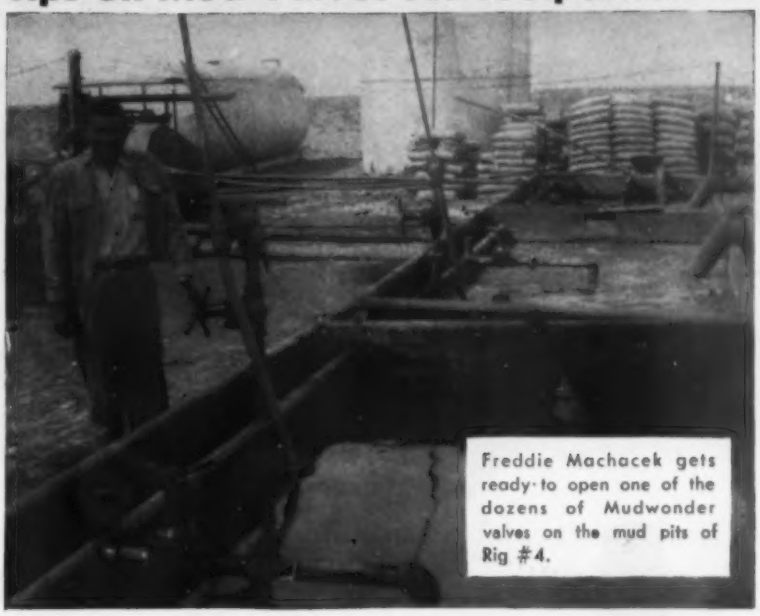
Circle number (32) on reply card.

Extruded Tubular Goods and Rotary Forgings

Two new brochures from the Metals Processing Division of Curtiss-Wright describe the company's extruded tubular goods and rotary forgings. The first brochure illustrates Curmet's extrusion process and includes a table of standard sizes and materials of the tubes, manufactured in sizes from 8 to 20 in. The other brochure illustrates rotary forgings, solid or hollow, hot or cold worked, forged to extremely close tolerances. *Metals Processing Division, Curtiss-Wright Corporation.*

Circle number (33) on reply card.

Tips on Mud Valves for Toolpushers . .



Freddie Machacek gets ready to open one of the dozens of Mudwonder valves on the mud pits of Rig #4.

MUDWONDER Ideal for Versatile Service

by Freddie Machacek, Toolpusher, Rig #4
B.B.M. Drilling Company, Midland, Texas

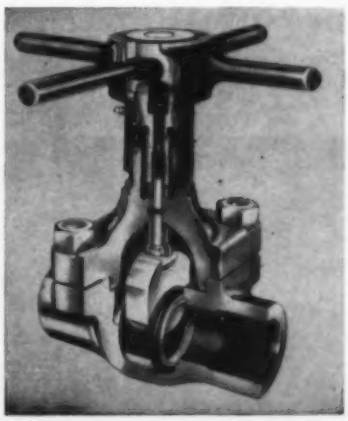
ABOUT two years ago I put a *Mudwonder* valve on our fill-up line just to see how it would make out. I soon found that *Mudwonder* worked fast and easily, without binding, even while bleeding off the line at 1600 lbs pressure. It did so well I tried more *Mudwonders* on the tough job of mud pit service—and they were so successful I've standardized on *Mudwonder* ever since!

Valves on mud guns and jets take a terrific beating, but we've had very little trouble with *Mudwonders.* As a matter of fact, our first ones are still in service; we replaced the stem packing on one valve—that's all! Because replacement parts are so easy to identify, we never have any trouble getting the exact part we need. In fact, the valves are designed to use the same seat and gate for both pressure classes.

When we have to dress a *Mudwonder,* the job can be done without disturbing any connections. The valve is out of service only about 10 minutes, start to finish, regardless of size. Another thing—they never sand up. Bob Lawrence, Edward *Mudwonder* Representative, says this is because the design causes the mud to flush the bonnet automatically.

Mudwonder valves are available in 2", 3" and 4" sizes; with screwed or flanged ends; rated at 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test). See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana, subsidiary of Rockwell Manufacturing Company.

Mudwonder cut-away view shows the one-piece seat insert, with Buna-N molded integrally over steel wear rings; chromed gate with "T" slot connection; separated stainless stem and double thread construction.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

YOU'LL BE GLAD YOU CALLED the FISHING TOOL DIVISION OF *Wilson Supply Co.*

...ON YOUR NEXT FISHING JOB

the right **TOOLS** and the right **MEN**

The Milling tools and Rotary Shoes shown here have been hard surfaced with crushed Tungsten Carbide.

"WHAT YOU WANT—WHEN YOU WANT IT"

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FABRICATION . . . of all types of equipment *(Fractionating Columns, Gas Columns, Pressure Vessels, Plate and Heavy Steel Work, Special Machines, Autoclaves, Shells, Base Bridge Girders)* . . . is performed to order . . . to specification.

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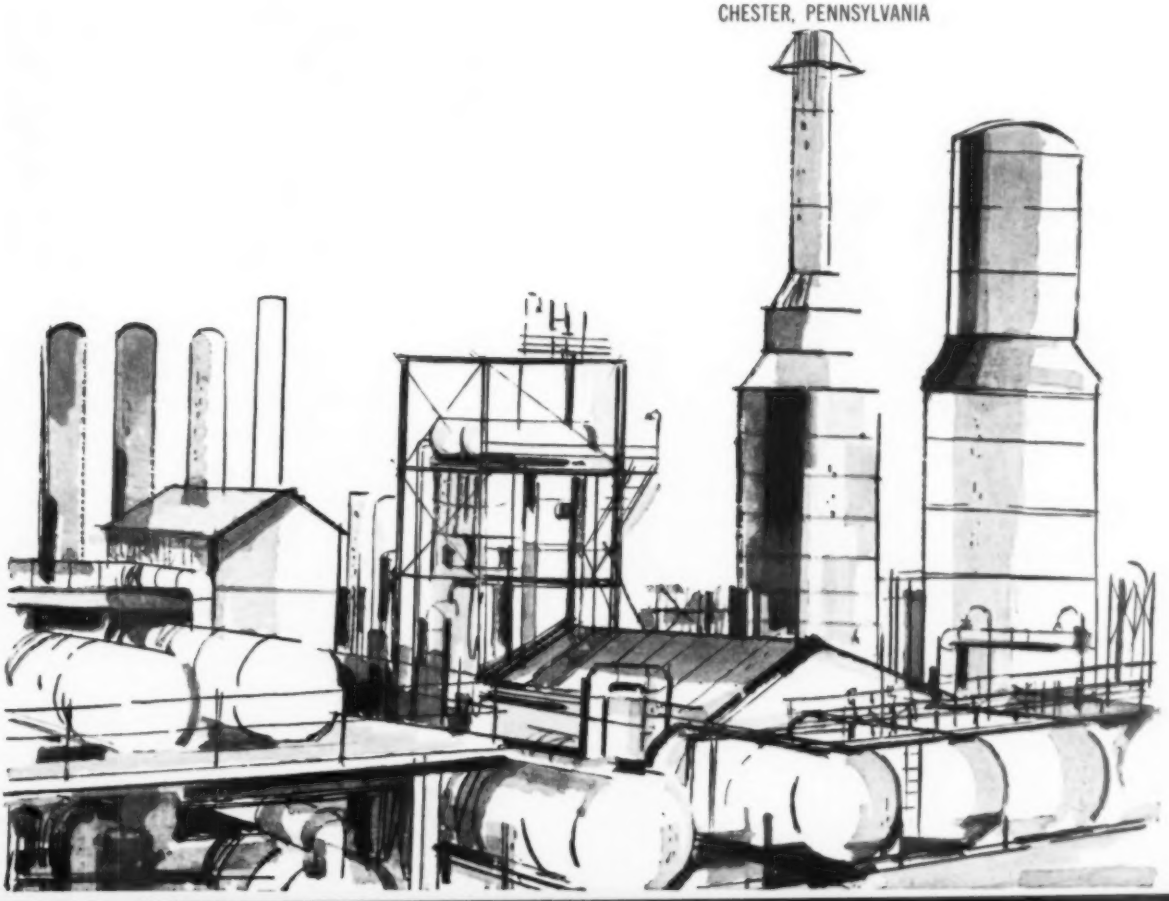
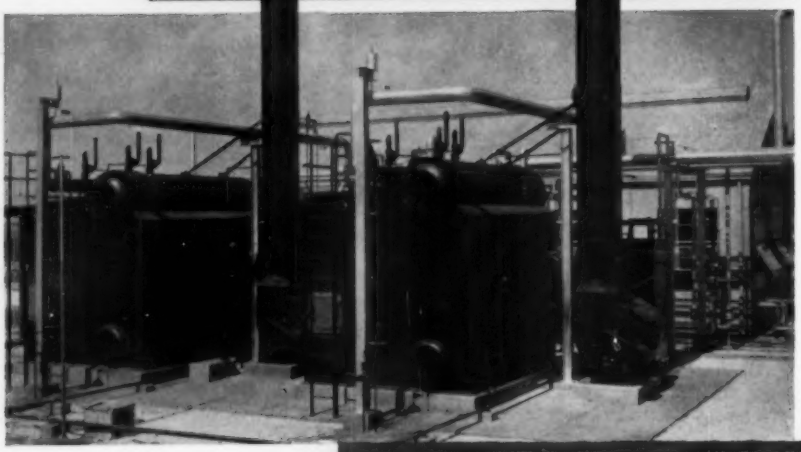
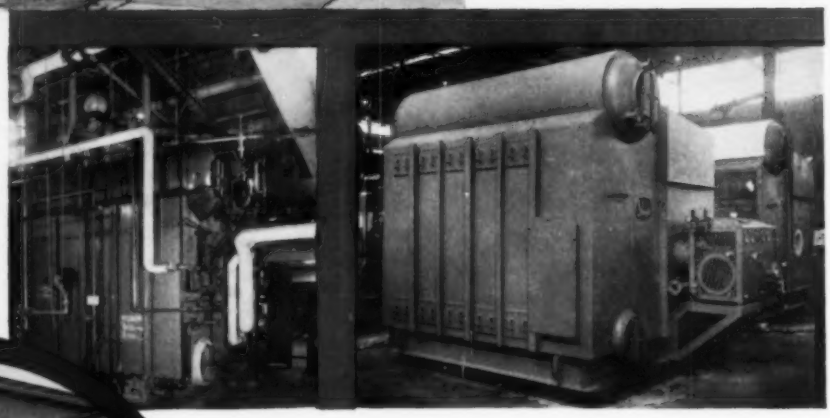


Vogt

Package STEAM BOILERS *give* versatility with economy

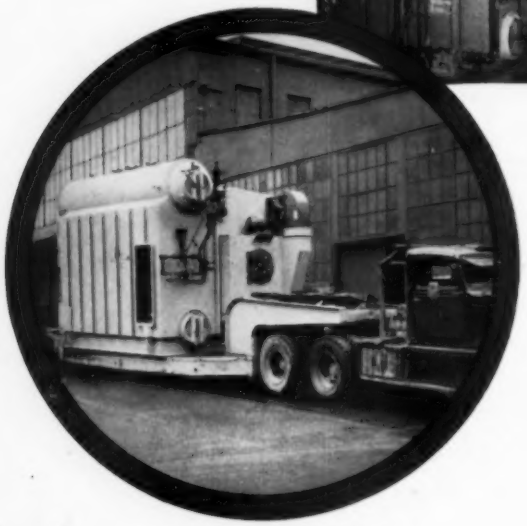




Above: Two units serve a gas pipeline company.

Left: Installation in fibre box-board plant.

Right: Unit for a leading soap manufacturer.



Enroute to an office building.

FOR POWER, PROCESS OR HEATING

Available in capacities from 10,000 to 50,000 pounds steam per hour in three standard pressures of 175, 250 and 375 pounds per square inch gage, factory assembled.

Write for Bulletin PSG-2, Dept. 24A-BRE

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

For better, longer-lasting protection—paint it with

Humble's protective coatings

In refineries and chemical plants where strong acids, alkalis and salt sprays produce severe corrosive conditions, Humble's protective coatings can save you hundreds of dollars in corrosion damage. Humble's protective coatings contain rust-preventing ingredients that not only provide surface protection, but also neutralize any corrosive substances that may get through the surface protection and attack the metal. And they give excellent resistance to weathering, plus good color and gloss retention.

Originally developed to protect Humble equipment, Humble's protective coatings have proved their value through years of extensive use, and are now marketed the world over. Included in Humble's complete line of protective coatings are RUST-BAN®, vinyls, epoxies, phenolics, enamels and others. These coatings are available in a wide range of finish colors.

Without cost or obligation, one of Humble's trained engineers will make a thorough study of your needs and recommend a complete painting program for you.

• *For detailed information on how Humble's protective coatings can save you money, call your Humble salesman, or phone or write:*

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Sales Technical Service
P. O. Box 2180
Houston 1, Texas

HUMBLE OIL & REFINING COMPANY **HUMBLE**

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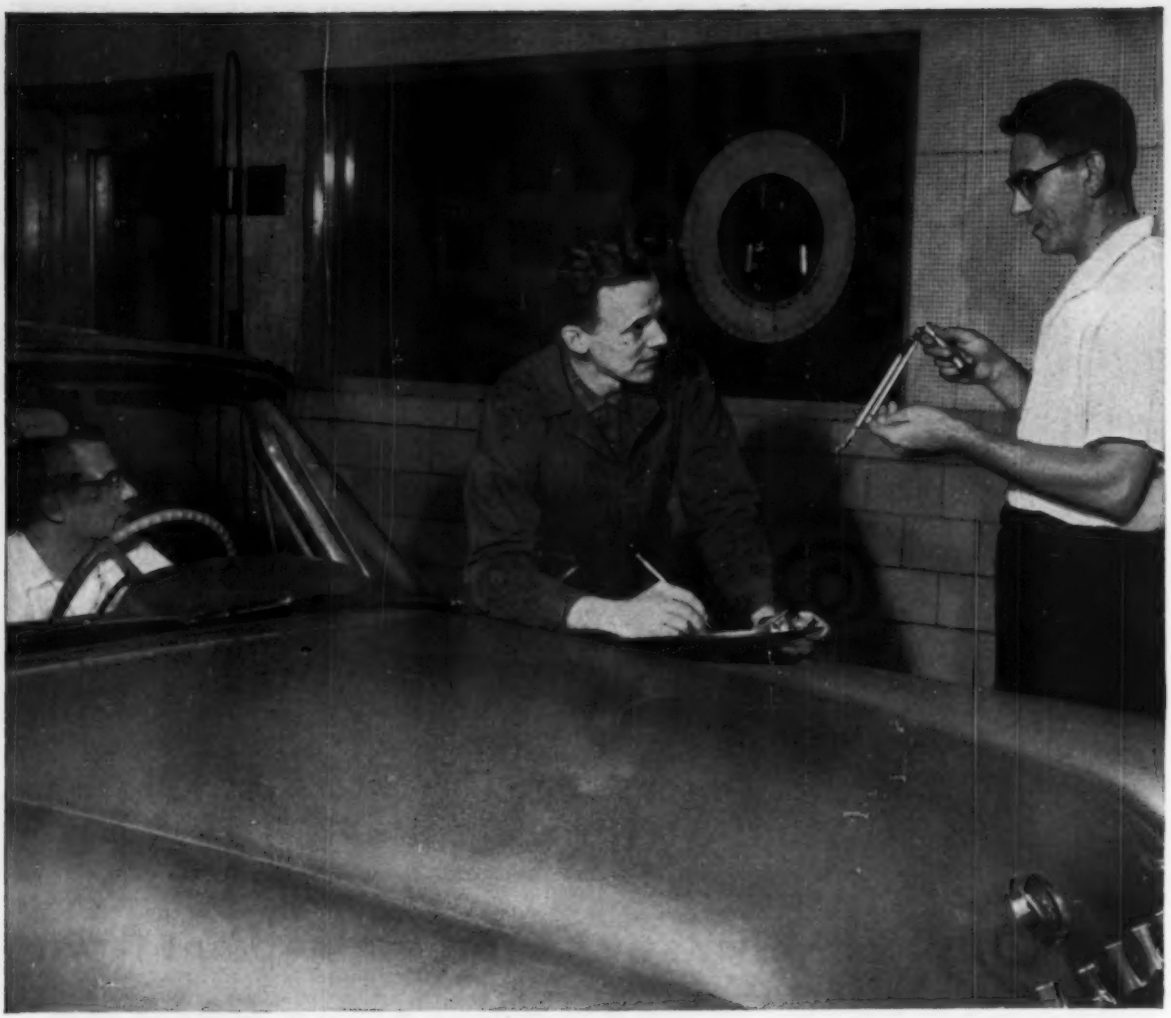


Checking humidity control setting in one of Ethyl's controlled-weather rooms

Ethyl Research reports the effects of temperature and humidity on fuel road ratings and octane number requirements

ETHYL Corporation's policy of keeping significant research data up to date and usable has produced a new study of the influence of weather and associated engine variables on fuel road performance and engine octane needs.

Refiners can use the results of this study to evaluate the effects of weather on the high-octane fuels they are producing for the high-compression engines of today.

In 1953 a similar study was conducted by Ethyl engineers. The results were published in an S.A.E. paper entitled, "Weather or Knock." The increase in compression ratios and the accompanying rise in octane numbers made it necessary to up-date the earlier research.

In the 1953 tests, cars with compression ratios of from 6.5-to-1 to 7.5-to-1 were tested on fuels ranging from 81.1 to 92.6 RON. This year, fuels from 96.6 to 99.8 RON were used in 10-to-1 compression ratio cars.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Conditions of the 1958 Test Program

The octane number requirements of two test vehicles were determined in terms of primary and commercial reference fuels at a number of combinations of ambient air temperature and absolute humidity.

Road ratings of six test fuels of various hydrocarbon compositions also were studied at these combinations. (See Tables I and II.)

Fuels were selected to represent a cross-section of commercial fuels now available. The Modified Borderline procedure was used in order to show the change in behavior characteristics throughout the engine speed range.

Road ratings were determined in duplicate on a chassis dynamometer in one of Ethyl's controlled-weather rooms at each of the selected conditions of ambient air temperature and absolute humidity shown in Table I.

Summary of 1958 Tests

The following general observations were made on engine octane number requirements (ONR) and fuel road ratings:

ONR increased when absolute humidity was held constant and the ambient air temperature was raised.

ONR decreased when ambient air temperature was held constant and the absolute humidity was increased.

Road ratings of test fuels decreased when the absolute humidity was held constant and the ambient air temperature was raised.

Road ratings of test fuels varied with changes in absolute humidity at constant ambient air temperature depending upon the temperature level and the hydrocarbon composition of the fuels.

It is important to relate the foregoing conclusions in terms of increase or decrease in the ability of a fuel to satisfy engine octane requirements.

With ambient temperature increase and constant humidity, the "satisfaction ability" decreases. "Satisfaction ability" increases with an increase in humidity when ambient air temperature is constant.

Comparison of Old and New Data

Data from the 1953 and 1958 programs agree directionally on the effects of temperature and humidity on octane number requirements, but differ in the magnitude of the change.

With respect to changes in fuel road rating, the new data do not agree with the data in the "Weather or Knock" paper where highly olefinic fuels are involved.

TABLE I

Ambient Air Temperature, °F.	Absolute Humidity — Grains of Moisture/lb. of Dry Air
90	160, 119, 78, and 30
60	78, 57, and 30
35	30

TABLE II

Test and Commercial Reference Fuels

	TEST FUELS						COMMERCIAL REFERENCE FUELS		
FUEL NUMBER	A	B	C	D	E	F	A[1]	B[1]	C[1]
Research ON	97.0	97.3	99.0	99.8	96.6	98.0	96.0	98.0	100.0
Motor ON	83.3	85.4	89.0	86.9	87.2	87.0	85.8	86.8	88.9
Sensitivity (RON-MON)	13.7	11.9	10.0	12.9	9.4	11.0	10.2	11.2	11.1
TEL, ml/gal	2.67	3.0	1.49	0.97	1.49	3.00	1.37	1.43	1.77
Hydrocarbon Type, Vol %									
Olefins	34	42	4	22	5	24	14.7	14.5	12.1
Aromatics	12	14	43	35	39	22	33.8	36.2	39.1
Saturates	54	44	53	43	56	54	51.5	49.3	48.8

How Ethyl Research is helping you

The work described here is one more example of Ethyl's service to the refiners by keeping them informed of latest developments pertinent to the fuel-engine relationship.

The complete report made of this study is available through your Ethyl Representative.

Just ask him for a copy of "The Effects of Temperature and Humidity Changes on Fuel Road Ratings and Octane Number Requirements," or write Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

ETHYL CORPORATION
New York 17, N. Y.

ETHYL ANTIKNOCK COMPOUND — ETHYL CORPORATION

RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

Demand to reach 64 billion pounds in 1962 . . .

Petrochemicals

Bright Outlook Continues

Herbert O. Jason
Boni, Watkins, Jason & Co.
New York, New York

SINCE WORLD WAR II, the petrochemical industry has experienced a rapid growth, has established itself, and is well on the road to becoming a key segment of the American industrial system. Developed initially out of the exigencies of war, the industry has advanced phenomenally through the implementation of fundamental research programs and the practical counterpart, the commercialization of laboratory breakthroughs. It now provides the industrialist and the consumer with a veritable cornucopia of new raw materials and novel finished products.

From an output of 9.2 billion lb, valued at approximately $1.0 billion in 1945, petrochemical production has risen to a present annual rate of 42.5 billion lb, with a wholesale value of $5.2 billion. This record represents an approximate 12 percent average annual rate of increase of physical output, compared with a 5 percent rate for all chemicals and approximately a 3 percent rate for the economy as a whole.

[Statistical measures are more than ordinarily subject to a liberal margin of error in this instance, because of the lack of general agreement upon the precise scope of the industry. In particular, the value figures must be used cautiously, since they represent a substantial amount of double-counting, including the value of materials at successive stages of processing and fabrication.]

Factors Pushing Growth

Phenomenal growth has been the result of techniques developed and experience gained in finding adequate synthetic substitutes for natural materials which were becoming steadily more costly, either because of depletion of fixed supplies (minerals) or because of mounting production costs (e.g., lumber). Persistent research culminated in materials which are often superior with respect not only to particular technical characteristics, but also to economic considerations.

The importance of the contribution of research to this achievement is indicated by the comparative expenditures on research in the petrochemical industry and in industry generally. At present, such expenditures constitute approximately 3.5 percent of petrochemical sales, while for industry as a whole they approximate 1.3 percent of total sales. However, another factor contributing to rapid progress in this field was the availability of an abundant supply of relatively inexpensive raw materials . . . basic hydrocarbons . . . in the petroleum and natural gas industries. Currently only about 2 percent of total petroleum and natural gas requirements is actually used for extracting petrochemical "building blocks." Thus, an adequate supply of raw materials for an indefinite expansion of petrochemical production is assured.

United States Petrochemical Production by Major Groups.
1957, and Estimates for 1958 through 1962

Year	Aliphatics	Aromatics	Total "Inorganics"	Total Petrochemicals
	billion pounds			
	(1)	(2)	(3)	
1957	25.9	3.6	10.3	39.8
1958	27.6	4.2	10.7	42.5
1959	31.0	4.7	11.4	47.1
1960	36.3	5.2	12.0	53.5
1961	40.2	5.4	12.7	58.3
1962	44.5	5.7	13.4	63.6
Annual Compound Growth Rate, 1958 to 1962	12.7%	7.9%	5.8%	10.6%

Basic Data Source:
(1) *The Oil and Gas Journal*, September 1, 1958, page 127.
(2) United States Tariff Commission, *United States Production and Sales, Synthetic Organic Chemicals.*
(3) United States Department of Commerce, Office of Business Economics, *Business Statistics*, A Supplement to the Survey of Current Business; and United States Department of the Interior, Bureau of Mines, *Minerals Yearbook.*

Near-Term Prospects for Petrochemicals

Our analysis of the current situation and established trends, recently completed, indicates a continuation of the surging growth of this industry. It is estimated that by 1962 petrochemical production will reach 63.6 billion lb. This represents a 10.6 percent average annual rate of increase of physical output volume. On this basis, the projected performance of the petrochemical industry surpasses by a wide margin that generally accepted as likely for the chemical industry as a whole and for the general economy.

Petrochemicals may be conveniently classified on the basis of their chemical characteristics as aliphatics, aromatics, and "inorganics." [Although these groups are treated as homogeneous, we recognize the divergent rates of growth inherent in the several elements comprising each of them. A detailed analysis of these elements would be necessary if these patterns were to be isolated and measured.]

Aliphatics. Of these three major "building blocks" of the industry, the aliphatic group is generally regarded as having the greatest growth potential. On the basis of a recently released article by Dr. R. L. Bateman, we estimate that output of this group will rise from the current (1958) annual rate of 27.6 billion lb to about 44.5 billion lb in 1962. This projection contemplates an average annual growth rate of 12.7 percent, the highest for any of the three basic product groups.

The versatile properties of the aliphatics, making them adaptable for a wide range of everyday uses, and their relative abundance (constituting more than two-thirds of the industry's physical output) are primarily responsible for this high growth rate. Moreover, the joint-cost nature of the industry's initial processing stage makes possible a flexible adjustment of the cost structure to take advantage of the exceptionally elastic demand for aliphatics.

Aromatics constitute the second most promising group from the standpoint of growth potential, though they constitute today only about 10 percent of gross physical output. From a present (1958) annual output rate of approximately

About the author . . .

Herbert O. Jason *is executive vice president of Boni, Watkins, Jason & Co., Inc., consulting firm with offices in New York, Washington, Rio de Janeiro and Sao Paulo. He is also president of Diversification Institute, Inc., a subsidiary of BWJ.*

Mr. Jason is no stranger to The Refining Engineer's *readers, having written the lead article for the March, 1958, issue* "Asphalt Demand—137 Million Barrels in 1960-67." *His opinions and forecasts on many products are widely quoted by many newspapers and magazines.*

Receiving his MME degree in Europe in 1937, Mr. Jason has since been engaged in administrative and consulting capacities in both America and foreign industries.

4.2 billion lb, it is estimated that production will increase steadily to a 5.7 billion lb level in 1962. Such a performance posits an average annual growth rate of 7.9 percent.

Inorganics include some of the longest known and most widely used chemicals, for example, ammonia, sulfur, and carbon black. However, none of these major inorganics is produced exclusively in petrochemical plants. Their markets are highly competitive, accordingly, and their output by the petrochemical industry is determined mainly by the capacity of installations and overall operating rate dictated by the markets for aliphatics and aromatics. Even so, their output currently comprises, in physical terms, about one-quarter of the industry's total. It is estimated that it will amount to somewhat more than 10 billion lb this year and increase to somewhat more than 13 billion lb by 1962. The projected average annual rate of increase comes to 5.8 percent.

Effect of Overall Economy on Petrochemicals

In substantial part, though far from preponderantly, the projected rate of growth in demand (and production) of petrochemicals is linked to the estimated growth rate of the economy as a whole. Since World War II the national economy, as measured by gross national product computations, has been expanding at an average annual rate of approximately 3 percent.

The major basis for projecting petrochemical expansion at a rate approximately three and a half times the "historic" (recent) rate for the economy in general is not an anticipation of an accelerating growth rate for the American economy. Rather, it is the demonstrated tremendous demand potential for the novel products research in petrochemical technology has made available, and is still supplementing. This fact, coupled with the indefinite expansibility of supply without any significant crippling effect on the service of supply of conventional petroleum and natural gas end-products, appears to assure a steep upward incline, over the near term, to the production and sales curves of this comparatively infant industry. ★ ★ ★

Oil's Demand for Aliphatic Chlorinated Hydrocarbons — Increasing 7 to 8 percent annually

A. J. Pastor
Technical Service and Development
The Dow Chemical Company
Midland, Michigan

CHLORINATED ALIPHATIC HYDROCARBONS are widely employed throughout the petroleum industry. These compounds are utilized in diverse applications as solvents in processes and plant maintenance, and as chemical intermediates. Most significant and perhaps best known applications are the use of methyl chloride and ethyl chloride in the manufacture of butyl rubber and tetraethyl lead. Some applications are decreasing in volume, but as a group the industry demand for chlorinated aliphatic compounds may be anticipated to increase at approximately seven to eight percent per year.

Chemical Intermediates and Reaction Media

In the neighborhood of 8.5 million lb of methyl chloride were employed in 1957 in the production of butyl rubber. At the extremely low reaction temperatures, methyl chloride is employed to solubilize the polymerization catalysts and maintain an even dispersion of polymerized products. While the large automobile tire tube market for butyl rubber considerably diminished in the past year with the advent of tubeless tires, new applications for butyl rubber have been developing. As a result butyl rubber consumption and hence methyl chloride use is anticipated to increase at the rate of 8 to 10 percent per year in the next three-year period.

The 1957 demands for ethyl chloride in the manufacture of tetraethyl lead were slightly in excess of 530 million lb. Associated consumption of ethylene dichloride and ethylene dibromide in motor gasoline additives was 496 million lb and 176 million lb respectively. Increases of approximately eight percent per year for these compounds are expected. A lesser application of ethyl chloride in the manufacture of ethyl benzene, accounting for approximately 2½ million lb in 1957, will likely grow at a rate of four to five percent per year.

New Area of Application — Dewaxing

Paraffin wax refining and oil dewaxing represent a new potential area of application for chlorinated aliphatic compounds. Ethylene dichloride has been employed in limited amounts for a number of years in some dewaxing operations. The demand for more highly refined waxes has revealed some shortcomings of ketone-aromatic dewaxing systems. As a possible solution to this problem, chlorinated solvents are being considered by wax producers in view of high degrees of selectivity at moderate temperatures and other possible process advantages in addition to reduced fire hazards. Corrosion problems reported in earlier dewaxing studies have been to a major degree eliminated by product purification and stabilization.

Solvent Applications

Oil well and pipeline cleaning with carbon tetrachloride and trichloroethylene represents the only application in which chlorinated hydrocarbon consumption is declining. For a number of years carbon tetrachloride, and to a lesser extent trichloroethylene, has been extensively employed in paraffin removal in oilfield and pumping operations. Refinery problems of premature failures of catalyst beds in reformer operations have been definitely attributed to relatively minute quantities of chlorinated hydrocarbons in feed stocks. Due to the magnitude of this problem, chlorinated hydrocarbon bearing feed stocks have been refused by most reformer operators. In the next two to four years use in this area will essentially be non-existent.

In the area of equipment and instrument maintenance, the use of chlorinated solvents and safety solvent blends comprised of chlorinated hydrocarbons and petroleum distillates have been receiving increased acceptance. Of recent introduction to this area has been 1,1,1-trichloroethane, almost unique in its solvent characteristics and low vapor toxicity advantages. These solvents and blends often permit rapid cleaning of equipment with little or no dis-assembly and offer the safety advantages of greatly reduced fire hazards. ★ ★ ★

Rapid growth puts the spotlight on . . .

WESTERN EUROPE'S PETROCHEMICALS INDUSTRY

Walter Sekules, *European Correspondent*

BY THE END OF 1959, Western Europe is expected to be producing petrochemicals at the rate of 1,200,000 metric tons,* compared with 200,000 tons in the middle of 1953. In the same period capital investments in the industry are rising from $240 million to $1,070 million. The petroleum chemicals industry is thus one of the fastest growing of all European industries. Moreover, creation of the European Common Market offers particularly favorable prospects in terms of larger production units catering for Continental instead of smaller regional markets.

At present, over 90 percent of raw materials for the petrochemical industry consist of petroleum feedstocks and refinery gases and less than 10 percent are natural gases. However, there are two major trends in evidence: Natural gas is likely to be used to a far greater degree in future. The biggest petrochemical expansion in Western Europe is taking place in France and natural gas is in good supply there. Italy and Germany are other producers of natural gas, likely to make more use of this material. The second trend is toward special production of many raw materials used by the petrochemical industry in self-contained plants. Both these trends will make the industry more independent of refinery operations.

Feedstocks Used by European Petrochemicals Industry
(Metric Tons; Source: O.E.E.C.)

Oil	692,000	763,000	880,000
Refinery Gases	355,000	586,000	787,000
Natural Gas	67,000	80,000	128,000

Major expansions will take place in butyl and styrene-butadiene (SBR) rubber, polyethylene, ethylene oxide derivatives, solvents and raw materials for plastics and detergents. The bulk of European ethylene oxide production at present is used for manufacturing ethylene glycol for anti-freeze products, but production of polyester textile fibers and synthetic detergents is increasing. Most of the new European ethylene oxide plants will use the direct oxidation process rather than chlorhydrination.

Since 1956, European sales of thermoplastics have been greater than the thermosetting types. This trend is likely to continue. The biggest expansion in plastics production is scheduled for polyethylene, from 80,000 tons in 1956 to 300,000 tons by the end of 1962. While production by the I.C.I. high-pressure process will be expanded, there is likely to be an even greater expansion in the use of Ziegler and Phillips low-pressure polyethylene processes. Production of polyvinyl chloride and, in some countries, of polystyrene, will increase at a smaller rate. Polytetrafluoroethylene, polyvinyl acetate, polyesters and epoxy resins will be produced in greater quantities. In an earlier stage of development are polypropylene and polycarbonates. These materials are expected to have considerable importance at a later date. The Italian Montecatini concern first developed polypropylene and established a plant, Farbwerke Hoechst followed in Germany. Polycarbonates are under development by Chemische Werke Huels in Germany and Petrochemicals Ltd. in England.

Newest branch of the European petrochemical industry is synthetic rubber. Production in 1956 amounted to 170,000 tons, and by the end of this year it should reach 300,000 tons. Plants are under construction in England, Germany, France, Italy, and the Netherlands. Production of synthetic detergents is still rising, but expansion has tended to slow down, from 21 percent in 1955 to 14 percent in 1956.

The main producing countries in Western Europe are Great Britain, France, Germany, Italy, and the Netherlands. Belgium and Austria are minor producers. Here is a country-by-country wrap-up:

Great Britain — World's Second Largest Producer

The British petrochemicals industry is the world's second largest. Capital investment at the end of 1956 was $170 million, an increase of $45 million in one year. Production in 1957 was about 260,000 tons. Expansion plans foresee an investment $144 million in plant coming into operation by the end of 1959. This means a doubling of capacity during just two and a half years.

Main features of the expansion are polyethylene, SBR rubber and ethylene oxide derivatives. Biggest projects are the two Imperial Chemical Industries plants at Wilton and Avonmouth. Some $200 million have already been invested at Wilton and another $50 million expansion is scheduled for the immediate future. A 7000 ton per year butadiene extraction plant went into commission in 1957, feeding a 10,000 tons per year Butakon plant. Some of the output is due to go to a new Italian rubber plant.

Production of Terylene (Dacron) at Wilton is being stepped up from 10,000 to 13,500 tons next year and another 9000 ton expansion is scheduled. Production of polyethylene is being increased by 50 percent to 90,000 tons per year in 1959, and ethylene oxide production is also being raised.

The I. C. I. plant at Avonmouth, covering a 1000-acre site, will cost $280 million. Scheduled for completion in 1970, it is the largest single petrochemical project in Europe.

The Shell Group subsidiary, Petrochemicals Ltd., is constructing at Partington an ethylene oxide plant with 25,000 tons per year capacity. This will be a direct oxidation unit using a process developed by Shell research, with pure oxygen used rather than air as the oxidizing medium. A large plant for the production of ethylene, required as base material for other chemical plants, is also under construction. An experimental plant for the production of 1000 tons per year of polyethylene by the Ziegler low-pressure process has been completed. The Shell Group has exclusive rights to this process in the United Kingdom. The polystyrene plant at Partington has been extended and it is also planned to erect a 15,000-ton monostyrene plant. At Shell Haven refinery, a large fertilizer plant is being built, using an oil gasification process developed by Shell.

Petrochemical interests of the British Petroleum group are centered at Grangemouth. B.P. and the Distillers Company share control of British Hydrocarbon Chemicals Ltd which operates two ethylene and ethyl alcohol plants at Grangemouth. Plants for the production of phenol and acetone are under construction. They are to use a Distillers Company process, already operating overseas, but now employed for the first time in England. A $22 million plant is being built at Grangemouth to produce high density polyethylene by the Phillips low-pressure catalytic process; it is expected to start operation early in 1959. Further expansion of ethylene

*All tonnages given here are metric tons.
Metric Tons × 1.102 = One U. S. Short Ton (2000 lb).

production is also under consideration. Completion of all these plants will bring petrochemicals production at Grangemouth to 200,000 tons per year, including industrial alcohol, isopropyl alcohol, monomeric styrene, butadiene, propylene tetramer and detergent alkylate. Detergent and plastics interests at Grangemouth are held by Grange Chemicals Ltd. . . . one-third owned by United States' Oronite Chemical Company . . . and Forth Chemicals Ltd., in which Monsanto has a one-third interest.

Fawley, where Esso has its United Kingdom refinery, will be the center of the company's synthetic rubber industry. A plant to produce 40,000 tons per year of butadiene should be ready by the end of 1958, supplying the International Synthetic Rubber Company's SBR plant. Other products will include ethylene and propylene. The SBR plant, built by a group including Dunlop, Goodyear, Firestone, and Michelin, will be completed this year at a cost of $23 million. Its capacity is 50,000 tons per year. Styrene for this plant will be supplied by Forth Chemicals and Shell.

Union Carbide is building an ethylene oxide plant at Fawley, using the direct oxidation process. Capacity will be 20,000 tons per year and the plant should be completed by next year. Union Carbide and Monsanto are both erecting high-pressure polyethylene plants of about 12,000 tons per year capacity.

France — A Six-Fold Increase

By the end of 1959, capital investment in the French petrochemicals industry will increase by $240 million, resulting in a six-fold increase in size of the industry. French production rose from 37,000 tons in 1955 to 50,000 tons in 1956 and 56,000 tons last year. New capacity coming onstream this year should bring a big production increase. Major expansion projects involve butyl and SBR rubber, ethylene oxide and derivatives, polyethylene, alkyl aryls, methanol, secondary butanol and methyl ethyl ketone and aromatics.

At Port Jerome, where the Esso S.A.F. refinery is undergoing expansion, a number of plants are under construction, including a 36,000-ton ethylene recovery and purification plant, an 8000-ton butadiene plant, a 26,000-ton alkylate plant and a 20,000-ton sulfur recovery plant. Société Normande de Matiéres Plastiques is building a polyethylene plant using the Ziegler low-pressure process, and Société Ethyléne Plastique Normandie is constructing a 10,000-ton plant using the I.C.I. high-pressure process. Société du Caoutchouc Butyl (SOCABU) plans to build an SBR plant of 40 to 50,000-ton capacity in the Port Jerome area, and a butadiene plant nearby to supplement butadiene from the Esso plant.

Europe's first butyl rubber plant was due to go onstream early in October in the Port Jerome area, with 20,000-ton capacity. France's first carbon black plant started operation in 1957 and should start drawing raw materials from Shell's Berre-l'Etang refinery. Initial capacity was 25,000 tons, to be doubled shortly to cover full French demand for carbon black. Société Marles-Kuhlmann is building an ethylene oxide plant of 8000-ton capacity at Gonfreville, near the Compagnie Francaise de Raffinage refinery. Tetrapropylene from a new plant at this refinery will be used in a detergent alkylate plant planned by Pétrosynthése S.A., in which Oronite Chemical holds an important share.

At Lavera, where Société Francaise de Pétroles B.P. has its refinery, Naphtachimie enlarged its cracking plant last year and increased ethylene production from 10,000 to 18,000 tons, to be raised again to 48,000 tons. Production of polyethylene by the Ziegler low-pressure process will start shortly. Total chemical production at Lavera is scheduled to reach 80,000 tons per year, including ethylene oxide, glycols, ethanolamines, glycol ethers, acetone and isopropyl alcohol. Expansion costs: About $45 million.

West Germany — Second Largest in Europe

The German petrochemicals industry made a rather late start due to post-war difficulties, but considerable expansion has now made it Europe's second largest. Production increased from 110,000 tons in 1955 to 134,000 tons in 1956 and around 165,000 tons last year. Between mid-1957 and 1959 the industry expects to double its size with capital investments of $150 million.

Erdoelchemie G.m.b.H., jointly-owned by the B.P. group and Bayer Leverkusen, plans to erect a large plant for intermediate petroleum chemicals next to the Bayer works at Dormagen, Cologne. Investments of $70 million are scheduled over a period of four years and petroleum feedstock will be supplied from the B.P. refinery under construction in the Ruhr area. Scholven Chemie, Gelsenkirchen, is completing a 6000-ton polyethylene plant using the Ziegler process. The new Esso refinery near Cologne will also be linked with a petrochemical plant, producing olefinic raw materials.

Farbwerke Hoechst is spending nearly $100 million on expansion, which includes a two-fold increase in polyethylene production and substantial increases in the Trevira (Dacron) plant. Farbwerke Hoechst also controls Anorgana, which is to install a cracking plant to produce olefinic raw materials. Chemische Werke Huels have started a new ethylene oxide plant and a plant producing tetrapropylene benzene for detergents.

Italy — Capacity Doubled During 1955-1957

Total capital investment in the Italian petrochemical industry stood at $51 million at the end of 1956, compared with $44 million in the preceding year. Some $280 million will be spent by the end of 1959. Output was 26,000 tons in 1955, 38,000 tons in 1956 and around 50,000 tons in 1957. By the end of 1959 new plant will come onstream at Mantova and Ravenna. Expansion plans involve methanol, polyethylene, ethylene oxide derivatives, styrene, polypropylene, propylene tetramer, secondary butanol, butadiene, polybutylene and SBR rubber. Polypropylene is now in commercial production by Montecatini under the Moplen brand name, at Ferrara, Azienda.

Nazionale Idrogenazione Combustibili S.p.A. is building an SBR plant at Ravenna with capacity of 35,000 tons per year, rising to 55,000 tons later. It will use natural gas from the Po Valley. Styrene will be supplied by a new plant also under construction at Ravenna. There are also plans for a number of new polyethylene plants, including one in Sicily under the control of Union Carbide and Italian Edison.

Netherlands

Located at the Shell Group's Pernis refinery, petrochemical production includes the first European glycerol unit. A 50,000-ton synthetic rubber plant is to be constructed by the Shell Group, and Algemeene Kunstzijde Unie together with Goodrich Chemical are to produce special purpose synthetic rubber. Two polyethylene plants, using the Ziegler and I.C.I. processes respectively, are under construction by Staatsmijnen, Limburg.

Belgium

A petrochemical plant costing $17 million is under development at Antwerp, producing ethylene oxide and derivatives, acetone and phenol by the cumene route, and raw materials for detergents.

Austria

A small petrochemical industry is likely to be established here during the next few years, centered on the nationalized Schwechat refinery. Production of polyethylene, ethylene oxide and polypropylene is under discussion, with German and Italian participation. ★ ★ ★

Consumption of Petrochemicals in Plastics—1960

Plastics will consume almost four billion pounds of basic organic chemicals . . . here's how petrochemicals will fare in this huge market

Charles E. Bethel, Jr.
Continental Oil Company
Houston, Texas

PRODUCTION of plastics and resins in the United States in 1960 will require about 3.9 billion lb of basic organic chemicals. Of this, petrochemicals will supply about 2.8 billion lb. These forecasts are based on a consideration of the potential growth in plastic end uses (about 8 to 9 percent per year) and the conversion of plastics output into raw material requirements. Output of plastics and resins expected for 1960 is about 5.5 billion lb.

The forecast, broken down by major chemicals consumed, is tabulated here. The chemicals listed are the basic ones — the most important building blocks from which other chemicals and plastics are made.

Some of these chemicals can be and are produced from other members on the list. For example, acetylene is produced in some plants from methane. However, such duplication has been avoided as far as possible, and the consumption shown is that used in making plastics—chemicals other than those already listed.

Petrochemicals Share

Petrochemicals are expected to supply 2.8 billion lb, or 72 percent of the estimated basic chemical consumption in plastics in 1960. This estimate is based on the percent of each basic chemical thought to be supplied by petrochemical sources. Petrochemicals make up 91 percent of the aliphatic consumption, but only 47 percent of the estimated aromatic requirements. Petroleum will probably remain the cheapest source in the United States for most of the aliphatic chemicals, whereas coking of coal will continue to be an important source of low-cost aromatics.

Many Routes Are Used

The basic chemicals are usually transformed chemically several times before they are incorporated into plastics. Methane, for example, can be changed into methyl alcohol, from methyl alcohol into formaldehyde, and from formaldehyde to pentaerythritol. Pentaerythritol is then used in making alkyd resins. Other plastics derived at least in part from methane are phenolics, ureas, melamines, and acrylics.

Plastics derived from acetylene are the vinyls, acrylics, and styrenes. From ethylene come polyethylene, polyesters, urethanes, vinyls, and styrenes. Propylene is a basic material for the production of polypropylene, epoxies, alkyds, and urethanes. Butylene is a basic material for styrenes and polyamides.

Benzene has perhaps the most prolific offspring. From it come the styrenes, polyesters, alkyds, phenolics, epoxies, polyamides, and urethanes. Toluene provides basic material for urethanes, as xylene does for the alkyds.

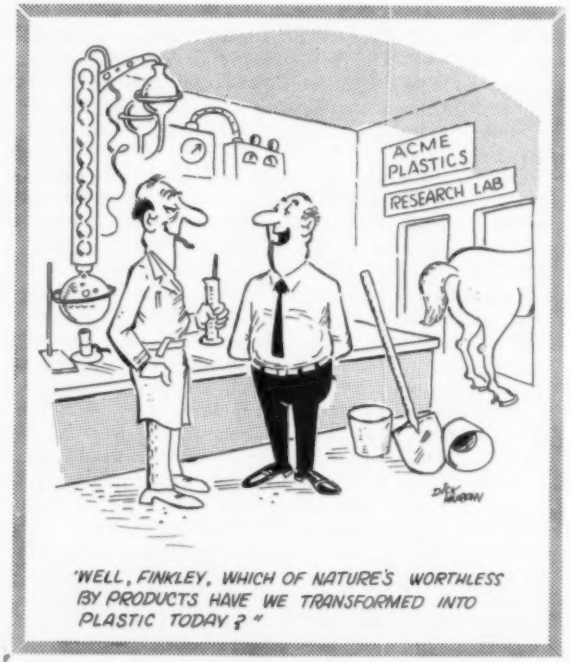
The continued growth in plastics output beyond 1960 will mean that this major outlet for petrochemicals will become even larger.

Estimated Consumption of Basic Organic Chemicals in Plastics — 1960
(millions of pounds)

	Total consumption in plastics	Consumption of petrochemicals for plastics	Petrochemicals' share of market
Aliphatic Compounds			
Methane	240	240	100%
Acetylene	370	180	49
Ethylene	1,160	1,160	100
Propylene	260	260	100
Butylene	190	190	100
Total Aliphatic	2,220	2,030	91%
Aromatic Compounds			
Benzene	1,380	680	49%
Toluene	100	90	90
Xylenes	40	35	88
Naphthalene	190	0	0
Total Aromatic	1,710	805	47%
Grand Total	3,930	2,835	72%

About the Author

. . . **Charles E. Bethel, Jr.** *is an analyst in the Marketing Research Division of the Continental Oil Company, Houston, Texas. He received an SB degree in chemistry from Harvard in 1949 and an SB degree in business and engineering administration from the Massachusetts Institute of Technology in 1952. He has been working in chemical marketing research since 1952.* ★ ★ ★


ACME PLASTICS
RESEARCH LAB
"WELL, FINKLEY, WHICH OF NATURE'S WORTHLESS BY PRODUCTS HAVE WE TRANSFORMED INTO PLASTIC TODAY?"

AROMATICS
—Has Supply Exceeded Demand?

Xylene isomers provide the brightest picture . . .

Robert C. Sweeney
Sinclair Chemicals, Inc.
New York, New York

THIS QUESTION provided its own answer during 1958 when the price structure of benzene, toluene, and xylene dropped considerably. First was toluene, which moved initially from 34 cents to a 29 to 31 cents per gal range on an f.o.b basis to an eventual 25 cents per gal delivered basis. Later, benzene and xylene moved to lower price levels, averaging about 5 cents per gal under their previous market prices. This was, of course, the aftermath of overcapacity and extensive competition for markets which have not grown to meet capacities.

A lot of consideration has been given to the justification of overcapacity in the aromatics field by the alternate use of these materials in motor and aviation gasoline together with the higher prices commanded by pure aromatics in chemical applications. While avgas does require relatively pure aromatics, this market is and has been declining for a few years and sufficient capacity was available for this use.

For motor gasoline, it is rather difficult, for the most part, to justify the expense of producing pure aromatics from aromatic mixtures such as produced by reformers; the octane enhancement value of these aromatics is the same whether left in the reformate or separated into pure aromatics. In the case of benzene, its naphthenic precursors have sufficiently high octane value before reforming so that further processing by reforming is not needed for motor gasoline utilization.

While it was true in the past that the prices commanded in the chemical market for pure aromatics justified the additional expense necessary to produce them from reformate, overcapacity and the resulting new prices established this year have changed the situation.

Unfortunately, it seems that a good portion of this recently added capacity was built on the basis of the magic of the word "petrochemicals" plus the image that this is the type of material that lends itself to building unlimited production capacity and "then let demand catch up to capacity." Basic raw materials such as aromatics just don't lend themselves to this type of planning, which is often necessary with certain other materials in the chemical industry.

It is certainly healthy to have overcapacity in any industry to allow for unexpected spurts in demand but we had overcapacity even before much of the new capacity was announced. The result has been a gradual erosion of prices with one reduction following on the heels of another, completely disregarding the fact that the coal tar industry has an entirely different situation with their aromatics than the petroleum industry. The coal tar industry has to move it or burn it. Not one gallon more of aromatics was sold at these lower prices than would have normally been sold. Even before these price cuts, the profits on aromatics were only fair, now they are almost nil. It may be possible that new uses will develop through these lower prices, but nothing is showing yet.

BENZENE . . . Imports Pose a Serious Problem to U. S. Producers

Total production of benzene was 332 million gal in 1957, with coal tar sources accounting for 216 million gal and petroleum benzene for 116 million gal. Capacity for producing petroleum benzene will soon be between 220 to 250 million gal. Without a doubt, one of the big influences on growth of domestically-produced petroleum benzene is the import of benzene from Russia and Poland. In 1957 imported benzene amounted to 55 million gal, equivalent to over 16 percent of domestic production. Even more significant is the 1956 benzene import level, close to 70 million gal.

While the new price level of 31 cents per gal approximates the value of the imported benzene delivered to the United States, the big question is what future prices will be for imported benzene. This, of course, would require a rather intimate knowledge of the Communist accounting methods. If recent events are significant, it appears that imports of benzene into the United States will continue at their present 50 to 60 million gal rate for the foreseeable future.

Elimination of this material from the United States market would bring a more healthy balance in the United States benzene supply-demand situation. If these imports of benzene continue, it is going to take quite a few years before industry starts consuming at a rate equal to the present capacity. Even if coal tar stays at the present 200 million gal capacity and demand hits the much touted 500 million gal figure by 1965, it will take seven years to catch up with present petroleum benzene capacity with imports continuing at the present level.

TOLUENE . . . Demand is Shrinking

This aromatic is a constant problem child. First is the problem of production of the desired quantities of benzene and xylene without producing excessive quantities of toluene. Second is that toluene in the past has been subject

to the whims of the requirements for aviation gasoline and munitions; both have gone through some rather vigorous cycles. As each year goes by, the shift to jet planes and the changes in munitions requirements make the long-term aviation gasoline and TNT outlook for toluene rather on the dim side.

During 1957 a total of 198 million gal of toluene were produced from these sources:

Petroleum	155
Coke Ovens and Tar Distillers	43

This represents an increase in production of 24 million gal of toluene from 1956. Reported sales meanwhile dropped from 135 million gal in 1956 to 130 million gal in 1957. Exports of toluene increased from 9 million gal in 1956 to 24 million gal in 1957.

While there are some bright spots in the future of toluene, such as growth in the toluene diisocyanate field, and possible increased use via methyl methacylate finishes, this still will not be sufficient to head off shrinking demand. Toluene firmed up for a while this year when the government came back strong into the avgas market after a year of restricted buying, but demand will probably not continue at this high level.

With the petroleum industry capable of producing approximately 220 to 250 million gal of toluene, together with 40 to 50 million gal from coal tar sources, for total capacity of 260 to 295 million gal, demand will be going the wrong way in an already over-crowded market.

Something new is needed in this market.

XYLENE . . . Capacity More Than Twice Demand

The petroleum industry has 90 percent of this market which dropped from 136 million gal in 1956 to 127 million gal in 1957. More interesting is that, if required, present operating capacity could produce from 220 to 240 million gal of material. On top of this, Sinclair will soon bring onstream a *para* xylene unit capable of also producing 60 million gal of mixed xylenes as a co-product, for a nice round total of 280 to 300 million gal per year of xylene capacity.

A considerable portion of xylene capacity is due to requirements for certain isomers of xylene which make it necessary to process large quantities of total xylene. Actually, capacity figures for pure xylene do not reflect the total quantity of xylene required, since large quantities of isomers, especially *para*, are produced without first producing pure xylene.

As with toluene, considerable quantities of xylene are used in aviation gasoline, which is on the downgrade. Solvent uses should grow but not enough to absorb decreases in the avgas market.

XYLENE ISOMERS . . . A More Cheerful Outlook

The isomers of xylene paint a better picture, with *para* xylene having a good future in the polyester fiber and film field. DuPont has announced expansion of their Dacron production with a new plant at Old Hickory, Tennessee, and Goodyear announced a new polyester resin plant based on DMT, to be located at Apple Grove, West Virginia. Others, such as Tennessee Eastman, have announced pilot plant production of polyester fibers.

While Hercules Powder and DuPont are the only two producers of dimethylterephthalate in the United States today, Amoco Chemical Corporation is due to bring a new 60 million lb per year xylene oxidation unit onstream which will produce various phthalic acids and also DMT from a mixed xylene feed. *Para* xylene capacity has been correspondingly expanded.

Unless markets other than phthalic acids develop for the *ortho* and *meta* xylene isomers, this is going to prove to be a very competitive situation. The future for phthalic anhydride has some strong points, such as in polyester laminating resins and plasticizers. But, in general, the long term growth does not look too promising since its main use, in alkyd resins, is facing a rough future.

During 1958 Cosden Petroleum Corporation announced new *ortho* xylene facilities at Big Spring, Texas, and Suntide announced plans for an *ortho* xylene unit at Corpus Christi.

The remaining isomer, ethylbenzene, besides being oxidized to benzoic acid continues to be studied for new expansions in the styrene field. Cosden has the only plant in operation producing styrene from xylene-derived ethylbenzene and this year started operation of a 22 million lb polystyrene plant to convert all their styrene.

About the author . . .

R. C. Sweeney is manager of market development for Sinclair Chemicals, Inc., the chemical subsidiary of the Sinclair Oil Corporation. He has a BS in chemistry from St. Joseph's College, Philadelphia, Pennsylvania, and has been active in the field of chemical market research and market development for the past 10 years. Member associations include the CMRA, CCDA, and ACS.

EXPORT . . . Overseas Capacity Reducing Demand on U. S.

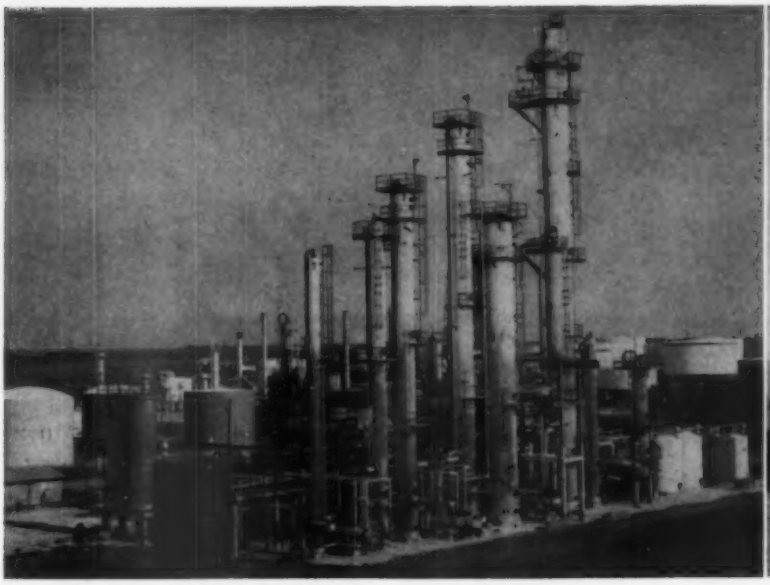
Export involves only toluene and xylene since benzene is very much on the import side of the ledger. Long range prospects are very dim with the entrance of several European aromatics plants into the field. Japan, which was a good market for aromatics, especially toluene, has been lost due to its own production.

The European Common Market will probably result in an ever-decreasing market for United States aromatics in Europe. Of course, considerable competition already exists for toluene in certain areas of Europe, from the Communist countries.

OTHER AROMATICS

Higher aromatics are also produced by catalytic reformers, depending on the feed to the unit. High flash solvents for baking finishes have been the main outlet for materials in the higher boiling range. These higher boiling aromatics include various isomers of tri and tetra-methyl benzenes, methyl-ethyl benzenes and other similar products. While considerable interest has been shown in some of these materials, such as pesudocumene and durene, nothing definite can be predicted for any of these at present.

In the *bi*cyclic field, considerable attention has been given in the past to producing naphthalene from petroleum. This interest has since been dropped due to very radical changes in market conditions. As with benzene, considerable quantities are coming from the Communist countries at very reduced prices of around 4 cents per lb delivered New York Port versus a current domestic price of 7 cents a lb. With the pending entry of a new source of phthalics from petroleum xylenes, this 7 cents per lb price for domestic napthalene will be under considerable pressure. ★ ★ ★



Heart of Vickers' petrochemical complex at its Potwin, Kansas, refinery is this Udex extraction unit. It is designed to produce about 15 million gal annually of BTX and heavier aromatics. Unit went onstream in June 1958, marking the company's 40th anniversary.

A 3500 bbl per day Ultraformer, completed last year, produces depentanized reformate, the feedstock for the Udex unit.

How . . . and Why . . . Vickers Entered Petrochemicals

This progressive Kansas independent just completed a $3.5-million complex for making aromatics. Here's the business and technical story behind this bold move

J. A. Vickers, Jr.
President
The Vickers Petroleum Company, Inc.
Wichita, Kansas

THE DECISION of the Vickers Petroleum Company to toss its hat into the petrochemicals ring in a year of soft markets might seem over optimistic to those who have not had an opportunity to study the advantages and disadvantages of such a bold move.

Profitable plant diversification is playing an increasingly important role in the efficient operation of an independent, fully-integrated oil company. Since petrochemicals are tagged as one of the fastest growing industries in the United States, Vickers' entry into the field with the completion of a $3,500,000 petrochemical complex at its Potwin, Kansas, refinery was a normal move of expansion.

Despite natural advantages which practically assure the Gulf Coast leading the petrochemical pack for some years to come, Vickers' 600-mile proximity to the major manufacturing centers of the United States was a prime factor in the decision to diversify.

Key processes in the complex are a 3500 bbl per day catalytic reformer (Ultraformer) and a Udex unit to produce 15 million gal annually of benzene, toluene, xylene and other heavier petroleum aromatics. The million-dollar Ultraformer was completed last year to protect and insure the company's position in the octane race and to provide feed to the Udex unit.

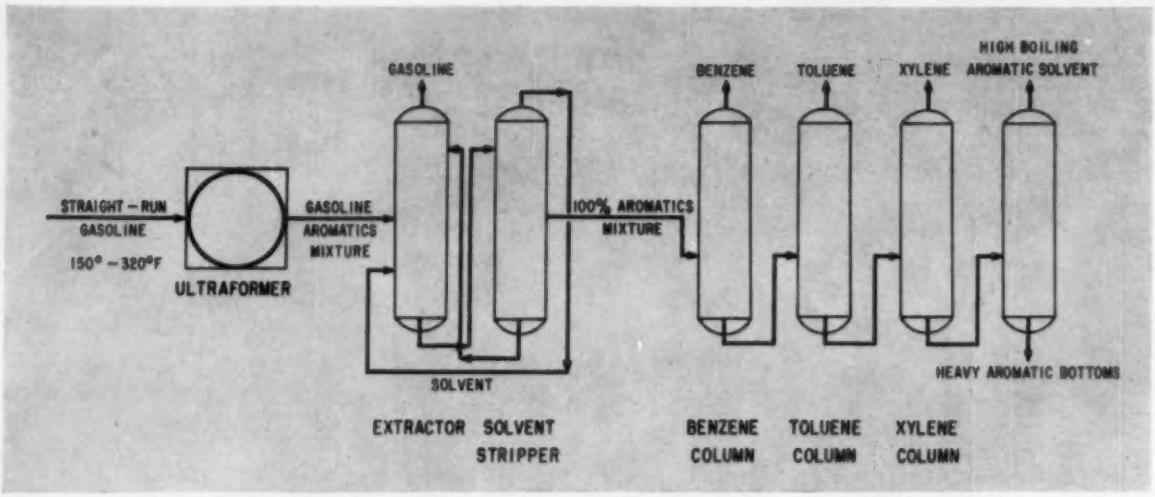
In June of this year, the heart of the $3.5 million petrochemical complex went into initial operation. Completion of the Udex unit, designed and licensed by UOP and built by Procon, marked Vickers Petroleum Company's 40th anniversary. Also, the BTX complex is the first petrochemical manufacturing facility ever built in Kansas by an oil company.

It is expected that Vickers' petrochemical plunge will do much to attract other industries to the Wichita area to take advantage of the sources of chemical raw materials that are presently available.

Wesley Sowers, president of Frontier Chemical Corporation, Wichita, stated recently that it is entirely foreseeable that a "clean" products pipeline from Wichita to riverside barge terminals on the Missouri and Kansas rivers at Kansas City would be a major project of the near future. This pipeline would then become a cost equalizer between the Great Plains area of Missouri and Kansas and the Gulf Coast.

Outlook for Aromatics

Although the petrochemicals market softened slightly this summer and early fall, Vickers is "bullish" regarding the future market for its benzene, toluene, xylene and other petroleum aromatics produced at its Potwin refinery. History of the growth of aro-



Simplified flow plan for the Udex unit. Instrumentation is entirely electronic; the control valves are equipped with electro-hydraulic actuators. The solvent mixture used is also unique.

matics demand supports this opinion.

Following World War II, demand for basic aromatics far exceeded the supply. Many new types of industries such as the plastics companies, firms which manufactured synthetic fibers and other industries consumed all available aromatics.

In 1946, total production of benzene, toluene, and xylene was only 247 million gal. In 1957, refinery and coke oven production combined amounted to 325,600,000 gal of benzene alone. A major petrochemical producer estimates that demand for benzene will reach 500 million gal by 1965.

Starting in 1957 and continuing to the present time, there has been a substantial increase in aromatics capacity and a relative decline in the rate of consumption. The latter is undoubtedly caused by the general recession as well as the depressed automotive market with consequent declines in new rubber tires and automotive finishes, both consumers of aromatics.

However, it is the responsibility of companies diversifying into petrochemicals to uncover new markets for their products through extensive market research and development. The present over-supply of aromatics is expected to balance out to meet demand with the current business upturn.

As an example, benzene has been the most in demand of the three aromatics. Last year, over 173 million gal of this commodity were produced. In 1965, this figure is expected to reach 335 million gal annually.

Demand for xylenes is also increasing rapidly; it is predicted to be 300 million gal by 1965. Last year, 136 million gal of xylene were produced.

Aromatics Enable Refinery Flexibility

Unlike several other individual products of a refinery, aromatics allow greater flexibility. Output of the Vickers Ultraformer can be diverted entirely to gasoline if and when market demands force such a move. According to most authorities, the dumping of aromatics stock back into gasoline will do much to prevent price-cutting in the field of petrochemicals simply to move the product.

Udex extraction of aromatics from paraffins and iso-paraffins allows higher octanes to be attained than by reforming alone. When operating a Udex unit for octane improvement purposes only, it is obviously not necessary to fractionate and purify the aromatic extract into individual pure chemicals.

How the Udex Unit Operates

Essentially, the Udex process is a selective liquid-liquid extraction method which separates and purifies aromatics from hydrocarbon mixtures. The Vickers unit will manufacture nitration-grade benzene, toluene, xylene, and other petroleum-derived solvents classified as having from 9 to 11 carbon atoms. Charge stock is depentanized catalytic reformate.

Vickers' Ultraformer produces this charge stock. In turn, feed to the Ultraformer is a 150/320 F straight run naphtha fraction, converted to an aromatics-rich stream over the platinum-containing catalyst. Reformate is depentanized and pumped to an intermediate point in the liquid phase extractor tower.

Stripped lean solvent enters at the top of the extractor column. Aroma-

About the author . . .

J. A. (Jack) Vickers, Jr. *is president and a member of the board of directors of Vickers Petroleum Company, Inc. He thus guides the destiny of one of the country's few remaining independent, fully-integrated oil companies. Youthful (33) Jack Vickers is a director for many organizations, including API, WPRA, IPAA and Mid-Continent Oil & Gas Association and is one of the youngest top executives in industry. He graduated from the University of Oklahoma in 1946, and joined the Vickers company as an oil scout. In 1949 he was named assistant to vice president in charge of the land department and in 1950 became vice president and assistant to president. He was named a director of Vickers Petroleum Company in 1951 and became president in 1952.*

Jack Vickers was recently named one of America's "Sixteen Bright Young Men in Business," by Esquire Magazine. Chairman of the governor's oil advisory committee for Kansas, he was named Oil Man of the Year last year by representatives of most of the industry associations in the state.

tics-rich solvent leaving the bottom of this tower is flashed in the top of the stripper column by reduction of pressure. Condensed stripper overhead is refluxed to the bottom of the extractor and lean solvent enters the top.

The aromatics mixture in the solvent leaves the stripper as a sidestream; stripping vapors are produced by a reboiler at the bottom of the stripper. Water layers from the stripper overhead and product receivers are combined and recycled to maintain composition of the extractor solvent.

Aromatic extract from the stripper is cooled, water-washed, and sent to a clay treater. Raffinate, almost completely paraffinic, leaves the top of the extractor, is cooled, washed with water from the extract washer, and sent to storage.

The combined wash-water stream, a minor portion of the circulating solvent, and makeup solvent as required are combined and pumped to the water still, the overhead from which is discarded. The bottoms are vacuum-distilled to recover clean solvent, with occasional rejection of traces of tarry residue.

Aromatic extract may contain traces of unsaturates, limiting the purity of the final products, and traces of residual non-hydrocarbon compounds which would spoil the acid-wash color test of the end products. To destroy these trace impurities, the extract is processed through a clay bed before final distillation.

The pure, clay treated mixture of benzene, toluene, xylenes, and higher boiling aromatics are then separated by a group of in-series fractionators.

Unique Design Features of Vickers' BTX Units

Although the Vickers Udex extraction unit is typical in many respects, use of electro-hydraulic control valve actuators and a mixed diethylene-glycol and dipropylene-glycol solvent made it quite unique in the industry.

The electro-hydraulic control valve actuators were selected to avoid the consequences of instrument air failure sometimes caused by leaks and freeze-ups. The dual solvent was chosen to increase recovery of C_9 and heavier aromatics, for which a heavier demand is expected in the near future.

In order to minimize water usage, a highly important factor in an area heavily hit by the drought of last year and several years previous, air-cooled condensors were installed. Other noteworthy features of the Udex unit include the all-electronic control instruments.

Of interest to refining engineers is another unique feature of Vickers' BTX complex. The Ultraformer is designed so that it can easily be expanded at a nominal cost. Most important, the reformer is guaranteed to handle up to one-third Dubbs Cracked Gasoline mixed in with straight-run gasoline.

Wesley Sowers, left, president of Frontier Chemical Company, Wichita, congratulates Jack Vickers on shipment of the first benzene ever made in Kansas. Vickers is Kansas' first oil company to build a petrochemical plant.

At present, the Dubbs gasoline is the least desirable in the refinery. As this matter becomes critical, the Dubbs gasoline can be incorporated into the reformer and can subesquently be converted to aromatics. The capacity of Vickers' BTX production increases appreciably if fewer high boiling aromatics are recovered for chemicals.

Organization of Marketing and Manufacturing Personnel

Far in advance of the actual starting of construction of the Udex, the Vickers Chemicals Division was formed. Doing much of the necessary research and feasibility studies was W. K. Jackson, now Vickers vice president of research and development and technical assistant to the president. A. B. Mullaly was named vice president, chemicals marketing and market development and Dewey Mark was appointed chemicals sales manager.

Expansion of any refinery into a petrochemical operation requires a like increase in trained personnel who can initiate improved operating techniques, eliminate unnecessary production bottle-necks and continue studies on plant modernization and expansion. New product development requires thorough process studies, economic evaluations and optimum use of new plant facilities.

Just recently, a refinery technical service department was established and added to the Vickers refinery staff at Potwin. Gordon D. Kerns was named technical director and is responsible for directing all technical activities at the refinery. Kerns coordinates the work of the technical service department with the overall refinery effort. Raymond S. Gibson is serving as senior process engineer. William L. Caldwell is development technologist and Donald R. Bolt, technical assistant.

An operating and supervisory crew of 20 and an enlarged laboratory group of 10 was required for the expansion into petrochemicals.

Results of the Expansion Program

Vickers' venture into petrochemicals has been most challenging, but rewarding. Many refinery authorities state that the addition of petrochemicals, completing the JAG . . . jet fuel, aromatics, gasoline . . . triangle, may well be the key to continued prosperity for the smaller refiner.

It is expected that Vickers' petrochemical operation might equalize the seasonal price and demand fluctuations in the gasoline and distillate fuel markets since the company can now channel the intermediate low octane number naphtha fractions into the most profitable and active market.

By taking advantage of the implicit competition which exists between the solvents and gasoline markets for heavy aromatics and also between the gasoline, jet fuel and distillate fuel markets for straight run naphtha, a more equitable return may be realized on initial investment for these components as market value and demand for the various products changes. ★ ★ ★

METAL HYDRIDES
—Petrochemical Newcomers

Robert C. Wade
Metal Hydrides Incorporated
Beverly, Massachusetts

METAL HYDRIDES are among the newest compounds attracting interest in the petrochemicals industry. Sparked by rapid developments in the high energy fuel field, many petroleum and petrochemical companies are rapidly pursuing the new developments of boron hydrides and aluminum hydride. Not so spectacular, but of solid significance, are new uses of sodium and potassium borohydride, lithium aluminum hydride, sodium hydride, calcium hydride, titanium hydride and zirconium hydride in petrochemical processes. While many of these projects are still in the research and development stage, rapid commercialization of a number is expected.

Borohydrides

Sodium borohydride . . . $NaBH_4$ . . . and potassium borohydride . . . KBH_4 . . . are chiefly known as water soluble reducing agents useful for reduction of aldehydes and ketones. The quantitative nature of these reactions has proved effective to "clean up" unwanted carbonyl color-formers or peroxides in petrochemical products such as oxo products, pentaerythritol, oxidized hydrocarbons, polyethers, amines, petroleum sulfonates, olefins, diolefins, and acrylonitrile.

In nonaqueous systems the borohydrides react with a boron halide to generate diborane . . . B_2H_6. This is the starting point for boron high energy fuels. More recently, however, new research has disclosed a process for the addition of diborane to olefins and other unsaturated compounds. Boron alkyls are formed quickly and in high yields. Internal olefins can be used and isomerization of internal double bonds to the alpha position can be made to take place almost quantitatively. Diborane and boron alkyls have been used in catalyst systems to polymerize many monomers, including olefins and vinyl chloride.

While demand for borohydrides is growing, an adequate supply for commercial uses has been available. Prices for potassium borohydride range from $13.50 per lb for 10,000-lb quantities to $20 per lb for less than 100-lb quantities. Sodium borohydride costs $33 to $40 per lb.

Large scale manufacturing facilities are now onstream producing these materials for the Navy. When this facility becomes available for commercial production, supply potential will be adequate for all anticipated commercial uses at greatly reduced prices — perhaps as low as $5 per lb for sodium borohydride.

Robert C. Wade *is a 1942 graduate of Oberlin College, holds an AB degree. His major industrial experience has been in alkali and alkaline earth metals and hydrides technology. He was formerly with Du Pont and National Distillers and Chemicals, engaged in sodium research. Mr. Wade has been with Metal Hydrides Incorporated since 1953 and was assistant director of research there prior to becoming manager of technical marketing.*

Lithium Aluminum Hydride

Like the borohydrides, lithium aluminum hydride ($LiAlH_4$) has been a research and development chemical for petrochemical process. This material is an ether-soluble, powerful reducing agent for organic compounds. Reaction with aluminum chloride in ether produces aluminum hydride . . . useful in Ziegler chemistry. Olefins add directly to lithium aluminum hydride to form the tetraalkyl derivatives. These have been used in catalyst systems for polyolefins and diolefins.

Lithium aluminum hydride is commercially available at $33 to $39 per lb. It is expected that large scale demands for alumino-hydrides will be met by sodium aluminum hydride at markedly reduced prices . . . estimated at $10 to $15 per lb.

Sodium Hydride

Sodium hydride (NaH) is available in large quantities at $1.25 to $2.50 per lb of contained sodium hydride as a 50 percent dispersion in mineral oil. A powerful alkaline condensing agent, sodium hydride developments are underway in monomer synthesis. Other demonstrated uses include: Olefin and diolefin polymerization catalysis, hydrogenation-dehydrogenation catalysis, and catalysis for alkylation of aromatic side chains with olefins.

Calcium Hydride

This unique hydride, CaH_2, is a powerful drying agent and is available in large commercial quantities at $2.50 to $3.65 per lb. The demand for super-dry hydrocarbons and organic materials has widened process research and development on calcium hydride. Water can be lowered to 1 ppm in many process streams. Completely-engineered commercial drying units using calcium hydride are under development, are expected to be available to industry in 1959.

As a source of hydrogen, calcium hydride may prove useful in secondary oil recovery processes. Reaction of calcium hydride with water in wells can generate very high pressures easily and cheaply. Development work is in progress. Calcium hydride is an effective co-catalyst for ethylene polymerization and catalyzes hydrogenation-dehydrogenation and double bond isomerization reactions with hydrocarbons.

Titanium and Zirconium Hydrides

These highly stable, solid-solution or alloy hydrides are available in large commercial quantities. They are now under investigation as selective hydrogenation catalysts in petrochemical processes. ★ ★ ★

A New Outlook for Butyl Rubber

Seemingly "on the ropes" after introduction of the tubeless tire, this versatile synthetic is bouncing back

J. L. Ernst and R. F. Leary
Enjay Laboratories, Inc.
Linden, New Jersey

A PETROCHEMICAL THAT STRETCHES . . . that's butyl rubber. Today it's being stretched to fit into more and more uses in factories, in automobiles, and in homes. Butyl is produced from refinery gases, catalytically polymerized in a split second to a versatile high molecular weight elastomer which is challenging all comers as a general-purpose rubber. This article will tell you what it is, how it's made, and what its present and potential uses are.

Butyl is based upon the discovery that isobutylene can be copolymerized with small amounts of diolefin to a high molecular weight vulcanizable elastomer. It is developed and perfected by Esso Research and Engineering Company, and is produced under U.S. 2,356,128 and other U.S. patents.

The first butyl was manufactured in a plant owned by the U.S. Government and operated by Esso Standard Oil Company. This plant and a second installation operated by Humble Oil and Refining Company were purchased from the government in April 1955, by their respective operators. Present world-wide capacity for production of butyl rubber is about 130,000 long tons per year, with an additional 50 to 60,000 tons' capacity scheduled for completion within two years (Table 1). Of the plant capacity presently in operation, about 105 tons per year is domestic and about 25 tons per year is in Canada. Butyl is marketed in the U.S. by the Enjay Company, Inc.

The major use for butyl rubber up to 1954 was in the manufacture of inner tubes, where the inherent advantages of superior air-holding and aging characteristics enabled butyl to displace natural rubber. The development of the tubeless tire, therefore, posed a really serious threat to butyl's future and resulted in a marked decline in demand during the period 1953 to 1956 (Fig 1). This challenge was met by aggressive product applications research, which resulted in the use of butyl in a wide variety of fields. Butyl today may thus be regarded as a general-purpose synthetic rubber rather than a specialty polymer. In the last five years, the domestic consumption of butyl in uses other than inner tubes has increased threefold from about 8.7 million to 25.2 million lb per year.

Total consumption of domestically produced butyl in 1957 . . . about 56,000 long tons . . . represents only a small portion of the total new rubber consumption of 1,464,000 long tons. However, butyl appears to be holding its position under 1958 conditions very well indeed compared with other types of synthetic rubber:

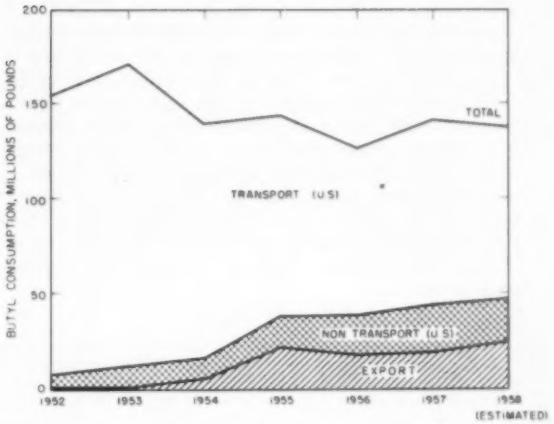


FIG. 1. Major use of butyl rubber was for inner tubes up to 1954. Introduction of the tubeless tire resulted in a marked decline in demand, now being arrested by development of new uses that mark butyl as a general-purpose rather than a specialty polymer.

Rubber Type	Percent Domestic Consumption Level 1958 Vs 1957 (6-Month period)
Butyl	92.5
Styrene-butadiene (SBR)	87
Neoprene	78
Nitrile rubber	84

It is expected that the broad base being established for butyl will continue to expand and that a strong growth rate will be resumed, with a favorable economic climate. The imminent commercialization of butyl in automobile tires could result in an almost explosive increase in demand.

Manufacture of Butyl Rubber

The synthesis of butyl rubber requires exact control of an extremely rapid, exothermic reaction at temperatures of the order of −150 F. Added to this criterion are requirements for extreme purity of the raw materials and for uniformly high quality of the final product. A simplified flow plan of the raw material preparation, polymerization, recycle, and finishing sections of a typical plant is shown in Fig. 2.

Raw material preparation. Although a large number of diolefins (butadiene, piperylene, dimethylbutadiene, etc.) copolymerize with isobutylene to form vulcanizable elastomers, commercial

TABLE 1. Butyl Rubber Plants.

Company	Location	Capacity Long tons/year	Status
Esso Standard Oil Company	Baton Rouge, La.	55,000	In Operation
Humble Oil & Refining Company	Baytown, Tex.	50,000	In Operation
Polymer Corporation	Sarnia, Ontario	25,000	In Operation
SOCABU	Port Jerome, France	20,000	Nearing Completion
Petroleum Chemicals, Inc.	Lake Charles, La.	30,000[a]	Planning

[a]Expandable to 345,000 long tons per year.

butyl rubber has always been a copolymer of isobutylene and isoprene. This choice has been based on availability, reactivity, and product characteristics.[1]

Isobutylene is obtained by sulfuric acid extraction of a C_4 olefin cut. Dilution and steam stripping of the extract, followed by caustic and water washing of the overhead, produces isobutylene of about 96 percent purity, with butene-1 and butene-2 as the principal impurities. Redistillation immediately prior to use increases the purity to better than 99 percent.

Isoprene for use in butyl rubber has been produced exclusively by extractive distillation of a C_5 fraction from thermal cracking.

Methyl chloride is used as catalyst solvent and reaction diluent. It is purchased from non-refinery sources in 99+ percent purity.

Catalyst preparation. Aluminum chloride is dissolved in freshly distilled methyl chloride to the extent of 0.05 to 1 percent to form the actual catalyst injected into the reactors. Maintenance of reasonably uniform activity from day to day is a critical control problem. Minute amounts of co-catalysts (proton-releasing substances such as water or organic acids) and poisons (polymerization chain terminators) can exert a profound effect on catalyst activity. Initial commercial operations encountered catalyst efficiencies . . . pounds of polymer per pound of aluminum chloride . . . which varied by a factor of at least 50 within short periods of time. Improved analytical techniques now used to monitor process streams have aided in bringing this problem under control.

Polymerization and recycle system. This section, the heart of the plant, carries the burden of producing uniform, high quality product in an economic and operable fashion. The process involves mixing diluted reactants and catalyst at about −130 to −150 F and overflowing the resultant slurry of rubber in diluent and unreacted hydrocarbon into hot water. Unreacted materials are flashed off and recycled, while the rubber is filtered out in the finishing section.

Operability requires a manageable slurry, with no agglomeration into lumps, in both the reactor and the flash tank. In the reactor, fouling of the heat exchange surface with a rubber deposit is an additional danger. The reactor slurry is reasonably stable when large amounts of diluent are present; methyl chloride does not dissolve or swell butyl rubber appreciably at reactor temperatures. Run lengths of 15 to 75 hours before termination for cleaning are described.[2]

In the flash tank, slurry stability is maintained by the addition of a small amount of zinc stearate, which appears to coat the polymer and form a nontacky surface. Disastrous plugging of lines and of the large flash tank itself has occurred when zinc stearate addition was interrupted.

Economic factors dictate the recovery of unreacted hydrocarbons and methyl chloride diluent. Most "poisons" . . . materials which reduce catalyst efficiency or product molecular weight or both . . . do not copolymerize to any large extent, and therefore would accumulate in the recycle streams unless appropriate purges are taken. Examples are butene-1 and butene-2, which enter with the isobutylene and must be rejected from the bottom of the recycle distilla-

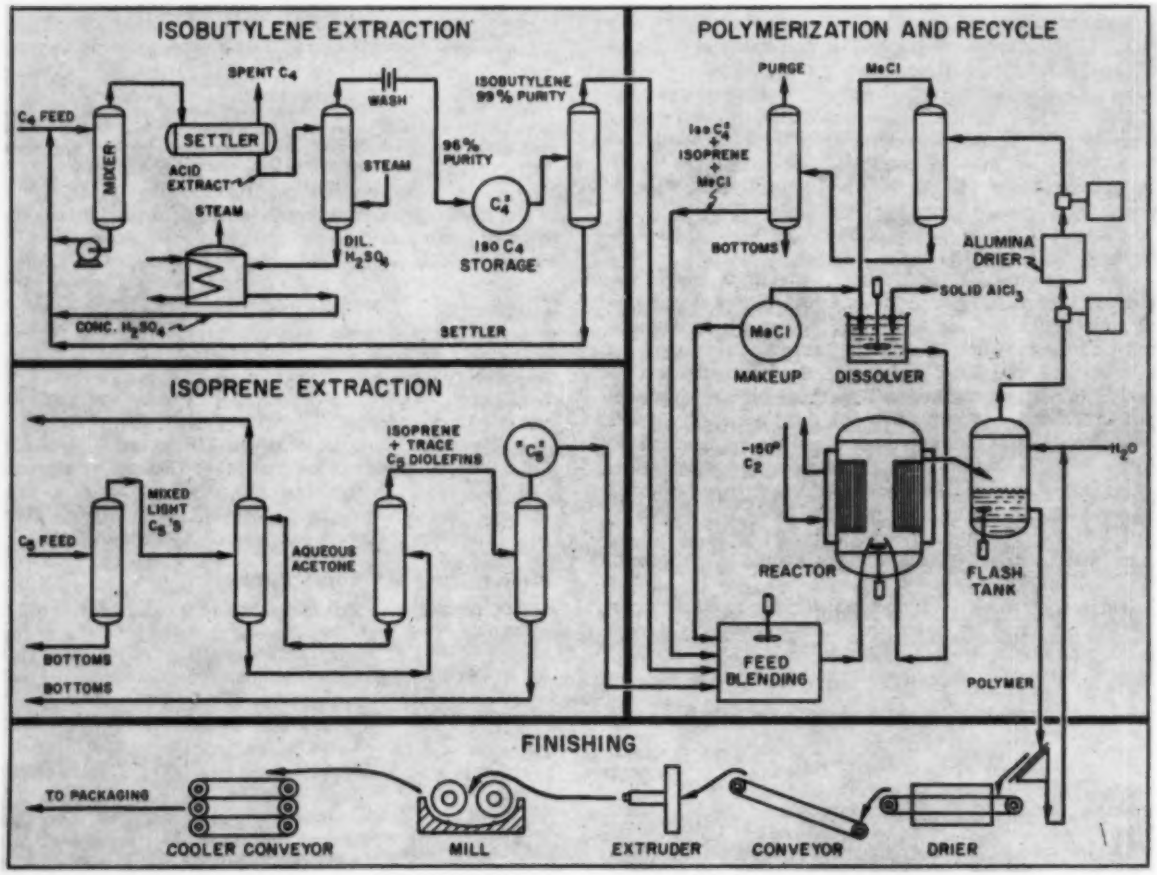


FIG. 2. Production sequence for butyl rubber, developed by Esso Research and Engineering Company. Isobutylene and isoprene are reacted at about −150 F, in a very rapid, exothermic reaction to form the polymer.

About the Authors . . .

J. L. Ernst *is section head in charge of the high polymers section at Enjay Laboratories, Linden, New Jersey. He joined Esso Research Laboratories in Baton Rouge in 1945, where he was connected with pilot plant and development studies on the manufacture of hydrocarbon polymers. In 1954 he joined Enjay Laboratories, where he has been in charge of polymer product development and sales service, particularly relating to butyl rubber. Ernst received his BA degree in chemistry from the University of Delaware.*

R. F. Leary *received his BS and MS degrees in chemical engineering from Columbia University in 1941 and 1942. He joined the Chemicals Research Division of Esso Research and Engineering Company in 1942 to work on process development problems in butyl rubber. His major fields of interest since that time have been production and separation of olefins, diolefins, and aromatics, and conversion of these materials into resins, drying oils, plastics, elastomers, and oxygenated chemicals. He recently resumed his interest in butyl rubber upon joining the Enjay Laboratories as assistant director in charge of technical sales service in the polymer field.*

tion tower. Isoprene is usually not recovered at the butyl plant itself, but is sent back to the extractive distillation section in this purge stream.

Product quality and uniformity are established chiefly by control of the molecular weight and the unsaturation of the copolymer. Several grades of butyl which differ mainly in the level of molecular weight and unsaturation are commonly manufactured, and it is necessary to be able to go rapidly from one grade to another with a minimum production of "twilight" material. The following fundamental variables influence polymer characteristics:

A decrease in *reaction temperature* increases molecular weight. Liquid ethylene, which boils at −150 F at atmospheric pressure, is generally used as a refrigerant in a jacket around the reactor.

An increase in *isobutylene concentration* increases molecular weight. In practice, the isobutylene concentration in the reactor is set by the degree of conversion, since the reactor contents are vigorously mixed and conditions are those of the exit material rather than the feed ("equilibrium overflow reactor"). Automatic equipment has been developed to analyze for unreacted hydrocarbon in the gases leaving the flash drum so that a constant watch on conversion can be maintained.

A decrease in *poison level* increases molecular weight. Every effort is usually made to exclude adventitious impurities which would reduce either molecular weight or catalyst efficiency.

Unsaturation is controlled by the amount of isoprene which actually enters the copolymer. Since isoprene copolymerizes more slowly than isobutylene, the ratio of isobutylene to isoprene in the reactor liquor and in the polymer is a function of conversion as well as feed composition. This again emphasizes the importance of maintaining a known conversion in the reactor.

The primary control on *conversion* is the ratio of catalyst solution to feed. Operators must constantly be alert for changes in the intrinsic activity of the catalyst, however, and adjust the flow of catalyst to compensate for these changes.

Finishing Section

The crumb rubber screened out of the water slurry from the flash tank must be dried, compacted, and packaged for shipping. The major portion of the water is removed in a tunnel drier, with the last traces being removed while the polymer is hot-worked and compacted by extrusion and milling. After air cooling, sheet from the finishing mill is cut, stacked, wrapped in polyethylene film, and boxed.

Antioxidant stabilizers are usually added in the flash tank, before the rubber is heated in contact with air. Both staining and nonstaining stabilizers have been used in commercial grades.

Properties and Application

When properly compounded, butyl possesses a number of advantages[3] over natural rubber and SBR.[3] The most important of these are:

1. Ozone and weathering resistance
2. Impermeability to gases
3. Electrical properties
4. Shock absorption
5. Heat and age resistance
6. Chemical resistance
7. Tear and flex resistance
8. Abrasion resistance

The excellent performance of butyl in the above areas is readily explained by the molecular nature of butyl relative to natural rubber and SBR (Fig. 3). Butyl is basically a long

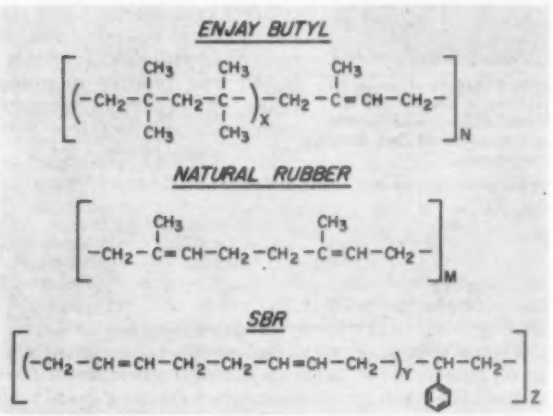


FIG. 3. Molecular structures of butyl, natural and SBR (styrene-butadiene) rubbers.

chain, closely packed paraffinic molecule having a low degree of unsaturation. The relationship of the molecule to its properties is described more fully in other publications.[4]

Nearly all engineering uses of rubber vulcanizates demand a combination of properties. The choice of elastomeric material to be used therefore depends upon obtaining the best balance of properties with the best economy possible. Obtaining this ideal system is more complex than simply evaluating the raw polymers. Compounding and processing changes can do much to affect this balance.

During the last four years considerable advancement has been made in the compounding and processing of butyl. Several outstanding examples of this are: (1) The development of a chemical promotor (Elastopar) to improve and control the resilience level of butyl[5]; (2) the development of entirely new cure agents (dimethylol phenol resins) which produce a butyl vulcanizate with an even higher degree of heat resistance than sulfur or quinoid vulcanizates[6]; (3) the development of improved hydrolysis resistant accelerators for steam curing (higher alkyl derivation of tellurium dithiocarbamate).[7] With developments of this type, rubber technologists are better prepared to meet engineering demands for better rubber structures in the butyl compounds.

Butyl in the automotive industry. Many rubber parts on today's cars are made of butyl because of its good weathering resistance (Fig. 4) and good grip to glass. One illustration is the rubber strip used to seal the large front and rear

FIG. 4. Results of ozone attack on a commercial synthetic rubber weatherstrip as compared to two butyl compounds.

windows to the body channel.

Butyl may also be specified where the rubber parts must be highly tear resistant and may have to go through paint drying ovens, thus demanding moderately good heat resistance... fender guards would be an example. Properties of butyl in this regard are shown in Fig. 5.

The dynamic properties of butyl... high damping (Fig. 6), low rebound, and general low resilience, have led to its use as shock absorbing material. Large blocks have been used to replace leaf springs in tandem axles for large trucks, saving 300 lb per trailer and providing a smoother ride, loaded or empty. The fact that resilience of butyl can now be varied over a wide range has opened new opportunities for the engineer to utilize more fully the energy absorbing properties of rubber-like materials. Typical rebound and relative damping values for two types of butyl compounds are compared with natural rubber below:

	Natural Rubber	Butyl-Elastopar Treated For Dynamic Damping	Butyl Designed For Maximum Shock Absorption
Rebound at 77 F, %	78.8	36.7	27.1
Relative damping, %	7.8	20.9	46.4

Typical uses in electrical equipment. A familiar sight in an oil refinery is the extensive electrical power distribution system. High voltage power cables have been made with butyl insulation for many years, principally because of its excellent dielectric and corona breakdown resistance properties, and its maintenance of these properties over long periods of use. More recently, an improved bus bar distribution system emphasizing butyl insulation and aluminum conductors has been developed. This design received a top award in the 1958 "Best Use of Materials" competition sponsored by the publication *Materials in Design Engineering*.

New techniques such as transfer molding have permitted engineers to take advantage of the electrical properties of butyl in still other electrical applications. Butyl compounds which exhibit good flow properties are transfer molded around the integral parts of a transformer and cured. This eliminates the use of expensive resins for insulation and also eliminates the normal metal casing. Some of the advantages claimed are: Attractive appearance, continuous operation at 125 to 150 percent of rated current, 50 percent greater allowable surge currents, mechanical overcurrent rating 180 times normal, and improved ruggedness.[8]

The technique of transfer molding butyl around transformers is also being considered for electronic parts as well. This will provide not only good heat resistant insulation but protection from shock and mechanical damage.

Use of butyl in chemical resistant applications such as tank linings, conveyor belts and the like continues to grow. In addition to these well-known applications, the increased use of synthetic detergents in household appliances has brought about increased demands for butyl parts for washing machines and dishwashers. The resistance of butyl to detergent and rinse aid solutions is shown by the volume swell measurements in Fig. 7.

One other major application cannot be overlooked. This involves the biggest single consumer of rubber, the tire industry. Progress toward a commercial butyl tire continues. In the fall of 1956, it was announced that an all-butyl tire had been successfully produced under pilot plant conditions. Summer, 1957, brought the next news when the Department of the Army announced its approval of an all-butyl tire for military vehicles. This made butyl the first commercially available synthetic rubber to be given approval for an all-synthetic rubber military tire.

Butyl tires have been subjected to millions of miles of test under general and severe service conditions and, in addition, butyl passenger tires have been test marketed by prominent tire companies. The butyl tire sets a new standard of riding comfort and safety and will soon be available to the motoring public.

Exact statistics are difficult to predict, but it seems certain that the use of butyl rubber will continue to grow and diversify. Butyl is firmly establishing its place as one of the more versatile members of the ever-growing family of synthetic elastomers. Modification of the basic molecular structure by chlorination or bromination can be expected to extend its usefulness still further.

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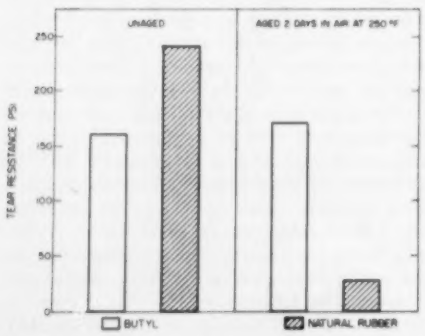


FIG. 5. Tear resistance for natural and butyl (50 parts SRF black compounds) aged, and unaged.

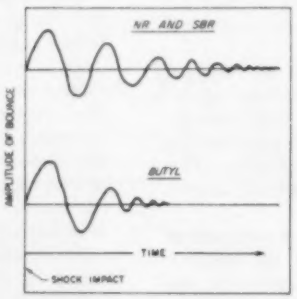


FIG. 6. Shock absorption diagram for butyl and SBR rubber, showing damping effect of each type.

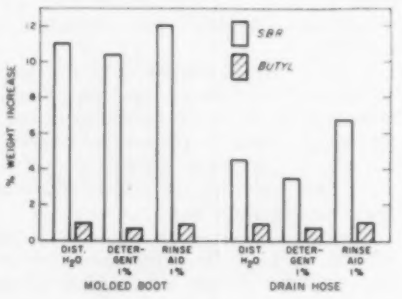


FIG. 7. Butyl vs SBR in appliance parts, 96 hours immersion at 160 F.

Processes and Products You Should Watch

Polyolefin Plastics

New dimensions have been added to this already vigorous industry by Phillips' linear polyethylene process, and processes built around the Ziegler catalyst. These processes are now demonstrating their flexibility by spawning still newer products, which perhaps will accelerate demand and tend to overcome the marked over-capacity situation. Clouding the situation, though, is the Du Pont "composition of matter" patent for polyethylene of specified density, melting point, degree of chain branching, etc. But, most feel that the patent problem can be resolved without seriously endangering low-pressure polyethylene's future.

Polypropylene capacity, worldwide, now totals 103 million lb annually. Montecatini's plant in Ferrara, Italy, is rated at 15 million lb and the Farbwerke Hoechst has a 68 million lb plant onstream in Germany. Sole U.S. plant to date is Hercules Powder Company's 20 million lb facility at Parlin, New Jersey. Humble Oil & Refining Company has announced plans, however, for construction of a 40 million lb plant at Baytown, Texas. Texas Eastman will soon have pilot plant production at Longview, Texas, using a process developed by brother company Tennessee Eastman.

The era of "tailor-made" polymers is here. Existing Phillips process plants have, for example, produced modified polymers with improved physical properties for their intended end use . . . a wide range of polymer densities can be produced economically without equipment modification. It is not unreasonable to assume that properties of polypropylene can be adjusted within limits, too.

Polyolefins are therefore ready to meet the challenge of huge markets in the field of packaging, where polyolefin films are challenging cellophane and paper and wax, fibers, and construction materials. Product development engineers might, by all reasonable expectations, solve the overcapacity problem much more rapidly than today's soothsayers believe.

Alkar

Economical upgrading of low-concentration olefins is the goal of this new UOP process. Total deethanizer tail gas . . . from catalytic cracking . . . is processed over an undisclosed catalyst to make ethylbenzene primarily, plus small amounts of cumene.

Local conditions, and the market for ethylbenzene and other alkylaromatics, will determine where this process can be profitably applied. This is an example of balancing feed purification against process requirements and product purification, with the selective catalyst chosen eliminating need for costly separation of ethylene and propylene in refinery gas mixtures.

Acetylene

Despite its "perennial bridesmaid" reputation, petrochemical acetylene is still expected to rival ethylene as a basic chemical building block. The question is when.

Newer processes for acetylene manufacture are getting attention. Tennessee Eastman has publicized a reactor to handle liquid feedstocks with either air or oxygen. Several U.S. engineering-construction contractors are offering the Belgian SBA process, which is based on an oxygen-fed reactor and ammonia as recovery solvent.

Phillips Petroleum Company has contacted much of the industry with a process based on a tangential reactor similar to its carbon black units, flexible as to feedstock and oxidant, with a low-pressure recovery system using dimethylformamide solvent.

Styrene

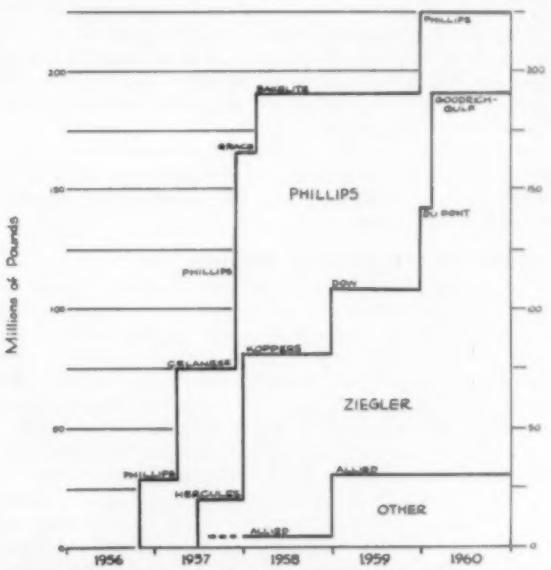
One of the most interesting developments in styrene is Cosden Petroleum Company's 20 million lb per year plant in Big Spring, Texas. Ethylbenzene is recovered from catalytic reformate by distillation techniques, converted to styrene, and polymerized to polystyrene . . . the world's first fully-integrated polystyrene production unit.

Cosden . . . and Foster Grant Company . . . have shown that ingenuity, aggressiveness, and sound engineering can serve as entrées to the styrene business. Styrene's basic position in the plastics, synthetic rubber, and paint industries warrants watching the progress of these companies, along with other key manufacturers such as Dow Chemical, Odessa Styrene Company . . . whose new plant at Odessa, Texas, can make 35-million lb annually of styrene.

Manufacturers are faced with overcapacity, a situation that many concede will extend into the early 1960's. Price reductions due to overcapacity and competition from other materials may serve to broaden styrene usage, however, and will certainly spur new applications.

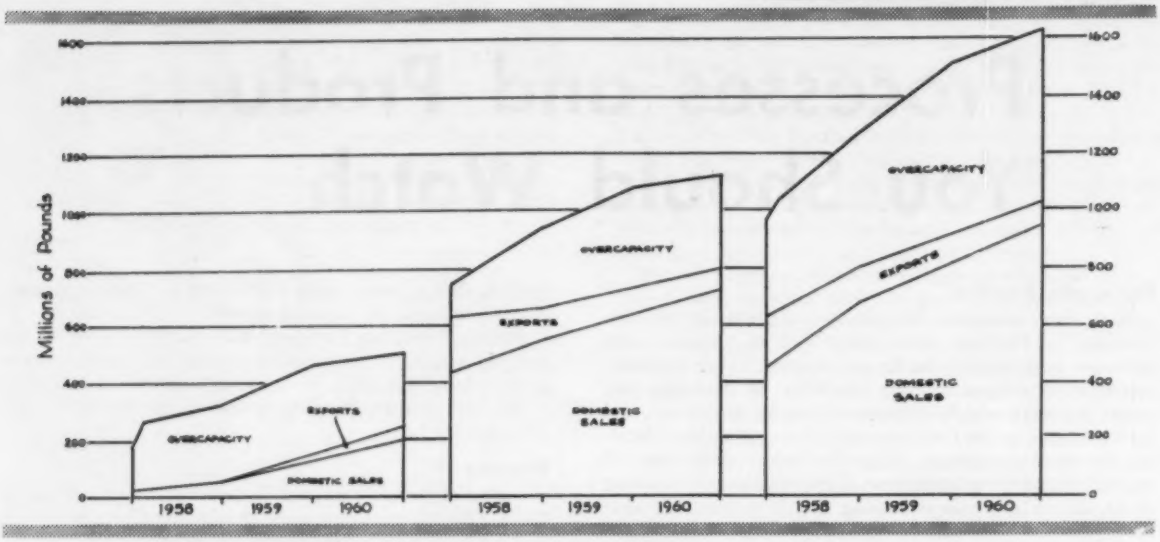
Synthetic Rubbers

Synthetic products have captured nearly 65 percent of



Source for this and following chart: "Linear Polyethylene and Polypropylene: Problems and Opportunities," Polymer Associates, 6613 Wenonga Road, Kansas City, Missouri.

Capacity for polyethylene — phenomenal growth.



Polyethylene overcapacity could trouble the industry for years.

the rubber market and may garner better than 70 percent of the total rubber market in the early 1960's. Despite expected declines in the export market, total demand for synthetic rubber should reach about 1.3 million tons (short) by 1960-61 . . . up about 10 percent from current consumption.

The dominant position of natural and styrene-butadiene (SBR) rubbers is now being challenged by two other products, butyl rubber and cis-polybutadiene.

Butyl rubber, while not new, is getting added capacity and bidding sharply for new markets, as an article elsewhere in this issue points out. Phillips Petroleum Company has revealed that its cis-polybutadiene "appears to be a very strong contender," plans to market development quantities soon (RE, October 1958, page A-7). Excellent performance in passenger car tires, established economical feedstock supply, and reasonable manufacturing costs are cited for cis-polybutadiene.

A broad family of polybutadiene rubbers can be produced, enabling synthetic rubbers "tailor made" for specific applications. By appropriate control of the catalyst system and polymerization conditions, polymers can be produced with controlled percentages of cis-, trans-, and vinyl-polybutadiene configurations.

Polyisoprene, on the other hand, may not develop into a real contender, despite its widely publicized attractive properties. Major stumbling block: The economics of isoprene monomer production.

Straight-Chain Primary Alcohols

Continental Oil Company's newly-announced process for making straight-chain primary alcohols, containing an even number of carbon atoms from 6 to 18 or above, heralds the petrochemical industry's concerted entry into a field now dominated by products made from natural oils and fats. Trade named "Alfols" by Conoco, these petroleum-derived alcohols will find extensive use in manufacture of products such as synthetic detergents, lube oil additives, plasticizers, cosmetics, emulsifiers, and paper and textile chemicals.

Plans are now being made by Conoco to build a multi-million pound per year plant for Alfol manufacture, according to Dr. John E. Kircher, manager of the company's petrochemical department. Five years in development at Conoco's Ponca City, Oklahoma, research facility, the process is based on earlier work done by Germany's Dr. Karl Zeigler. Major competitive point, according to Dr. Kircher: Availability of straight-chain primary alcohols from a stable and economical source.

Tonnage Oxygen

The impact of tonnage oxygen on the process industries is illustrated by the new oxygen-based ethylene oxide plants. Process men are watching closely to see how this technique compares with the air oxidation and chlorohydrin routes. Whether nitrogen should be removed before or after reaction is pertinent to many oxidation processes . . . ideas flowing from ethylene oxide production experience may be profitably applied to analysis of other cases.

Tonnage oxygen may find its way into petroleum refining quickly, too. Cities Service Oil Company recently reported the success for oxygen enrichment of catalytic cracker regeneration air, based on plant-scale tests, arousing the interest of many other companies (RE, October 1958, page A-7).

Methods and costs for producing oxygen . . . and other aspects of cryogenics . . . will be discussed in a feature article in December 1958's *The Refining Engineer*.

Octafining to Increase p-Xylene Yields

Atlantic Refining Company's new "Octafining" process . . . a modification of the basic platinum catalyst reforming process . . . is one solution for the old bogey in para xylene manufacture: What to do with the ortho and meta isomers which are in relatively lower demand.

First application will be in Japan, at Mitsui Petrochemical Company's terephthalic acid plant to be onstream next year. Feed to the unit is mixed with recycle isomerizate, para xylene removed by crystallization or other suitable means, and the remainder charged to a system consisting of feed heater, a single reactor filled with platinum on silica-alumina catalyst, a high-pressure separator, a tower to remove light by-product aromatics, and a fractionator to separate ethylbenzene and the xylene isomers from heavier aromatics formed in small quantities in the process. Reaction is in a hydrogen atmosphere.

Feed to isomerization would typically contain about eight percent para xylene, while the product prior to para xylene removal would contain about 19 to 20 percent para xylene. Operation can be modified to boost yields of ethylbenzene, ortho- or meta xylene.

This is still another example of how new processes can help petrochemical manufacturers balance their yields with market demands. ★ ★ ★

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New Tool Speeds Converter Head Plug Removal

Joseph Karol
General Zone Foreman
The Atlantic Refining Company
Philadelphia, Pennsylvania

Six men, armed with an unwieldy battering ram, needed two eight-hour shifts to remove these 4½-in. collar stud nuts until . . .

. . . this newly-developed 3-in. drive impact machine was purchased. Two men need only 1½ hours to take off the 16 nuts.

REDUCTION of process unit maintenance costs and downtime is of major concern in every plant. Maintenance engineers at The Atlantic Refining Company found that tool manufacturers can furnish some of the answers to the costly maintenance problems connected with high-pressure process equipment.

Case in point: Solution to a major shutdown bottleneck—removal of the head plug from the 4000 psi ammonia synthesis converter in Atlantic's ammonia plant.

Designed with a Bridgeman closure-type seal joint, the head plug can be removed by turning the jacking bolts on the perimeter of the head collar, after removing sixteen 4½-in. collar stud nuts.

Head Plug Removal — A Costly Job

The first obstacle was removing the collar stud nuts. The 1-in. drive impact machines that were available could not begin to loosen the big 4½-in. nuts. The only equipment in the plant that could do the job was a battering ram suspended from a chain block and a large hammer wrench. This operation took six men at least two eight-hour shifts.

Once the collar stud nuts were removed, the head plug could not be jacked; the retainer ring, clamped on the head plug to transfer the jacking pressure from the head collar, failed to withstand the necessary pressure. Thus, removal of the head plug was a lengthy process. The 38-in. seal follower ring had to be drilled and tapped in place so that it could be removed by a special rig. In addition, the massive head flange was heated by a gas torch to provide as much clearance as possible while removing the ring. The 38-in. copper seal gasket could be removed only by drilling and gouging.

Corrosion around the seal follower ring was found to be one thing that prevented the head plug from being jacked from the shell. To prevent future seizure, the ring was machined to increase the clearance between it and the head and shell from 0.002 in. to 0.040 in. Then, all gland surfaces were buffed and coated with a corrosion-resistant paint.

Re-assembly of the head tightening of the collar stud nuts for a pressure test took six men three to nine shifts.

Solution: A Tool Designed For the Job

In an effort to reduce the cost of the entire operation, an investigation was made of various tools on the market which would help simplify the work involved. A newly-developed 3-in. drive impact machine was obtained on a trial basis. A 1-in. drive 4½-in. chuck was then converted to fit the new machine. A heavier retainer ring, designed to withstand the necessary jacking pressure, was fabricated.

When shutdown time arrived, the maintenance force was fully equipped to meet their task. The sixteen 4½-in. collar stud nuts were removed in just 1½ hours by the new impact machine. The heavier retainer ring was installed, and the jacking process started. Two men, using small impact machines, easily snapped the seal loose in a half hour. The head plug, seal follower ring, and copper seal gasket were then removed as one unit. The re-assembly operation, using the new impact machine, was completed by four men in only four hours.

Savings Many Times Tool Cost

The new machine saved 30 mandays of work. More significant, however, is the value of the production gained by having the plant back onstream two days earlier than on any previous shutdown. In addition, the dangerous practice of six men using a 250 lb battering ram was eliminated. And the machine can be used on two other similarly-designed vessels in the refinery.

It is estimated that the savings paid for the new tool four times over, in just one shutdown. Needless to say, the machine was purchased shortly after completion of the shutdown.

Cooperation Key to Solution

As process unit and machinery designs change, the maintenance engineer must be prepared to solve major maintenance problems. One man cannot do this alone. He must work hand in hand with process engineers, tool engineers, and, most important, the tool vendor. These people hold the key to successful solution of many maintenance problems. Cooperation with them saves maintenance dollars at Atlantic Refining Company. ★ ★ ★

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AMMONIA
—Long Term Outlook Good

Russell P. Westerhoff
Ford, Bacon & Davis, Inc.
New York, New York

THE SYNTHETIC AMMONIA INDUSTRY, main source of chemical nitrogen fertilizer, will have to increase capacity about 80 percent to meet farm and industrial needs by 1975. At today's costs, this will represent capital outlays of approximately $400 million.

Existing ammonia capacity, with a value of some $500 million, totals about five million tons per year and leads the petrochemical industry in terms of tonnage. Further, ammonia bids well to outdistance its own swift post-war growth.

Main reasons for this optimistic outlook: Increased requirements for soil enrichment, a mushrooming use for blasting (as ammonium nitrate), and lower cost production and transportation techniques that are on the horizon.

Growth in Agricultural Use of Ammonia

While the volume of "total fertilizer" *produced* went from 10.90 billion lb in 1910 to 40.83 in 1955 . . . an increase of less than four times, the volume of available nitrogen *used* grew from 0.283 to 3.511 billion lb . . . an increase of over 12 times.

Increase in nitrogen application to soil was low from 1900 to 1940, reaching a value of two pounds per acre, then more rapid to the current value of approximately 10 lb per acre . . . roughly a five to one boost in the 15 years between 1940 and 1955.

In 1955, the fertilizer industry consumed some 4200 out of the 6500 million lb of ammonia produced in the United States. The major portion of this production was from petrochemical sources, the balance from by-product coke ovens and natural sources. From 1953 to 1956, petrochemical production accounted for the following percentages: 75, 85, 90, and 90 of all ammonia produced.

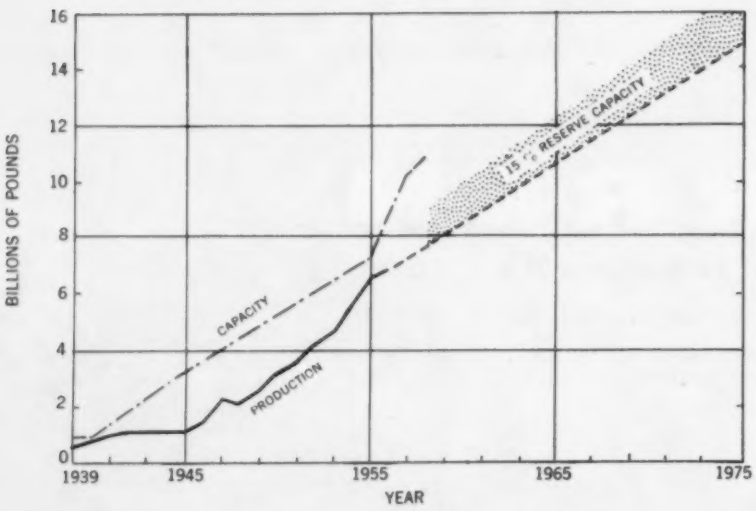
Forces Pushing Future Growth

Lower prices would tend to boost consumption, in addition to the other pressures such as population growth, degradation of plant enrichment compounds already in the soil, and desire to increase productivity per acre. With natural gas selling at 20 to 30 cents per thousand cubic feet, it is generally possible to produce ammonia for $30 to $40 per ton, while the current selling price of ammonia is about $88.

With the area of cropland in use in the United States more or less constant at 400 million acres, and population growing well past the 200 million mark by 1975, there is valid inference that greater quantities of food must be yielded as the years pass. If the present rate of increase in feeding the soil is maintained, the national average application of nitrogen per acre should at least double to about 20 lb in the next 17 years. The Netherlands is already spreading a national average of 156 lb per acre of arable land; Belgium, 84; West Germany, 46; Norway, 38; United Kingdom, 31; Sweden, 20; and France, 15.

These soil enrichment needs alone could preempt existing ammonia capacity in a few years. Further, in addition to some 8 million lb of new capacity for predictable agricultural and industrial uses, some $50 million worth of new capacity will have to be built concurrently to meet demands from ammonium nitrate as an explosive.

U.S. AMMONIA PRODUCTION & CAPACITY



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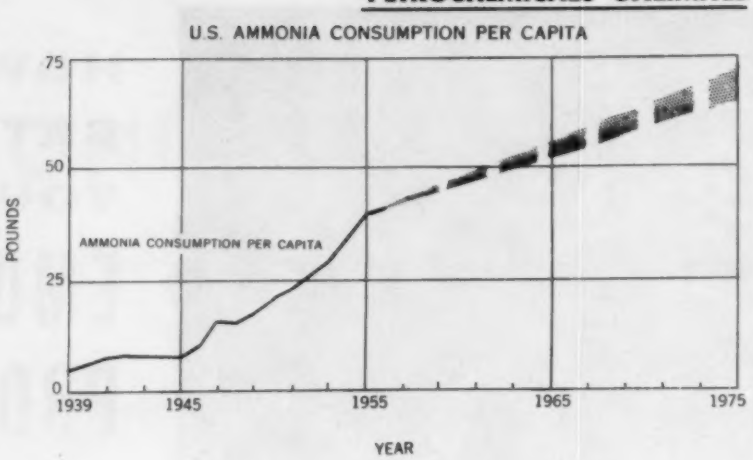


Ammonium nitrate is coming into its own as a preferred material for controlled blasting. The 1956 figure of 300,000 tons for this use will be tripled by 1975, it is believed.

Exports of nitrogen fertilizers will also contribute to the growth of the industry, increasing 200 percent by 1975.

Urea Growth Rapid

With the exception of anhydrous ammonia, urea contains the greatest concentration of ammonia. For this reason, performance of this chemical requires mention.

Total urea production in the U. S. was 350 and 842 million lb in 1955 and 1956, respectively. The amount derived petrochemically rose from 70 to 80 percent in the same period. In 1956, 494 out of 842 million lb were sold as fertilizer, almost 60 percent of production.

Urea production capacity in 1959, made available by current expansions of some 340 million lb annually, will reach 1,550 million lb annually. Future expansion includes a 146 million lb per year urea plant contemplated by Sun Oil Company and Olin Mathieson Chemical Corporation, for construction at Marcus Hook, Pennsylvania.

Key Role of Better Transportation

The farmer has a choice of fertilizers, and geography plays a role in his final selection. He buys from the nearest manufacturer to minimize transportation costs. In turn, the manufacturer attempts to advantageously locate his plant near both raw materials supply and market.

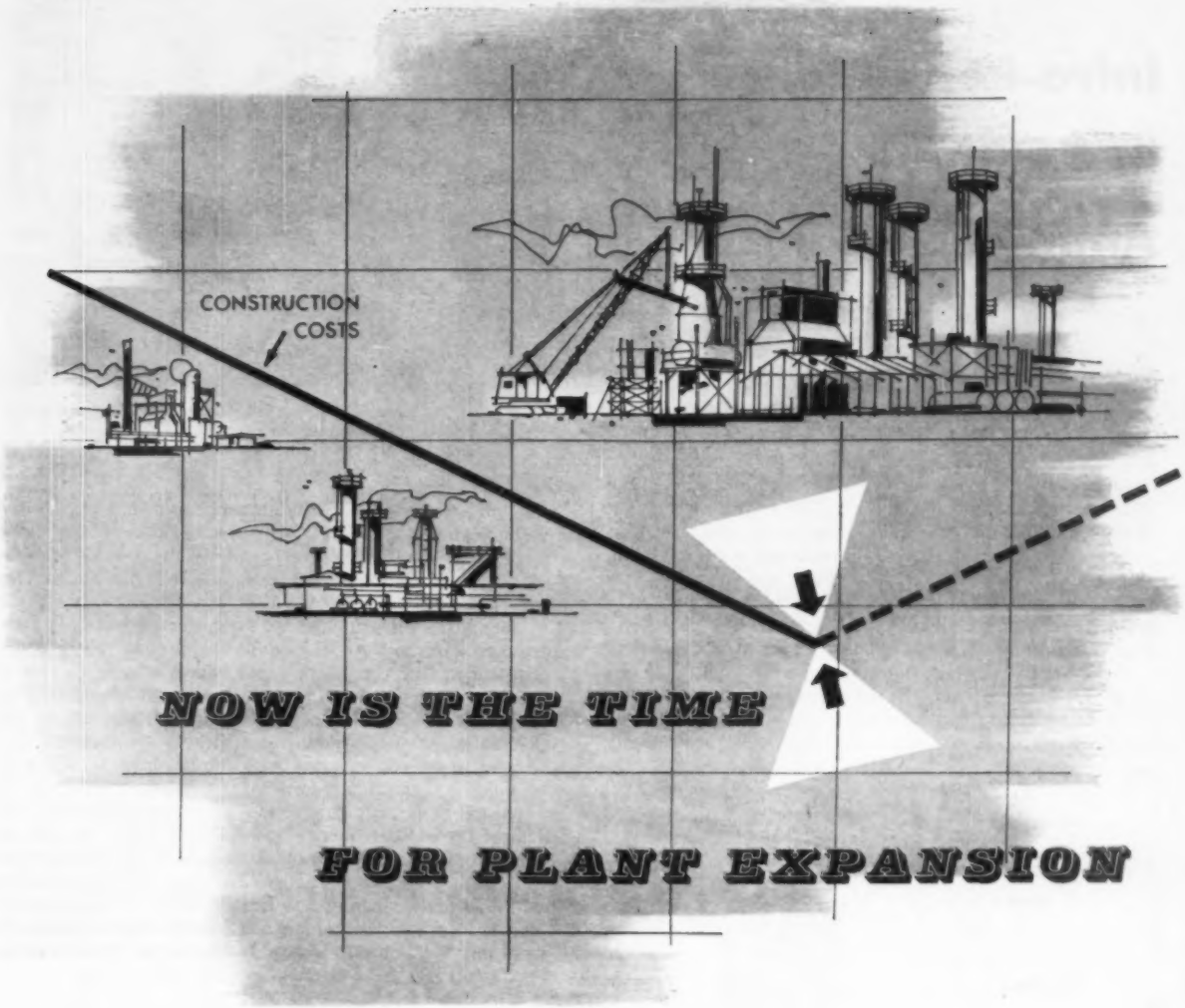
Natural gas, phosphate rock, and sulfur are the major raw materials of the fertilizer industry. Natural gas is, of course, pipelined in. Present cost of transporting phosphate rock and sulfur is high. Sulfur, at its source, is valued at about $23 per ton . . . to transport it several hundred miles by rail adds $11 to its cost. Phosphate rock f.o.b. mine ranges $4.50 to $7.25 per ton, but shipping by rail over similar distances brings the cost to roughly $9.50 per ton.

If sulfur and phosphate rock were also carried by pipeline, using techniques already proved for transport of coal and Gilsonite in slurry form, transportation costs would be reduced greatly. Also, the manufacturer would have greater flexibility in locating his plant advantageously.

Pipelines play an increasingly important role in the petrochemical industry by lowering production and marketing costs. Low-cost ammonia is the firm foundation on which the fertilizer industry . . . by far its major consumer . . . may base its future growth. Pipelines, used more extensively, may permit the fertilizer manufacturers to further reduce his costs for the benefit of the American farmer and, indirectly, the nation as a whole. * * *

About the Author . . .

Russell P. Westerhoff *is a director, vice president, and manager of the engineering department for Ford, Bacon, & Davis, Inc., New York consulting and engineering firm. He is also a director and vice president for the company's construction affiliate and Canadian subsidiary. Mr. Westerhoff completed his education at M.I.T. in 1928, holds both bachelor's and master's degrees in civil engineering from that institution. He belongs to many professional societies and is a national director of the National Society of Professional Engineers.*



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Infra-Red Analysis in Synthetic Ammonia Plants

MEASUREMENT OF RESIDUAL METHANE immediately downstream of the reformers used for partial oxidation of methane in natural or refinery gas in synthetic ammonia plants is quite important. Methane concentration is, of course, an indication of reaction efficiency, thereby enabling the operator to make process adjustments when there are temperature changes or a shift in methane content of natural or refinery gas being used as the raw feedstock.

Analysis of methane in the reformed gas presents a difficult problem. The gas stream is "dirty" and contains steam saturated at a high temperature and pressure. Here's how the problem has been successfully solved at the Mississippi River Fuel Corporation ammonia plant at Selma, Missouri.

There are five partial oxidizers or generators at the Selma plant. Product gas from any of these can be continuously analyzed by one of two infra-red analyzers, using a special sampling system constructed for this particular problem.

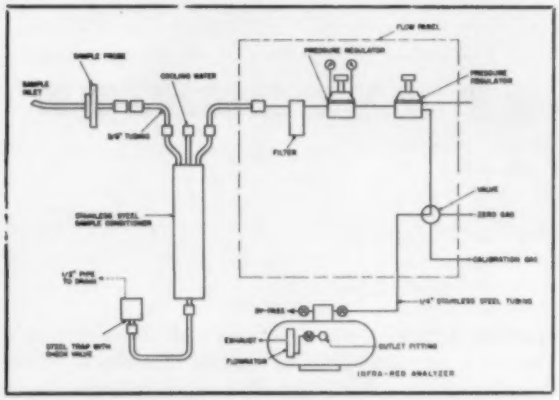

FIG. 2. **Sampling system diagram.** Generator product is steam saturated at 400 psig. Unit was designed and built by M-S-A.

Sampling System

The sampling system, as shown on the flow diagram, consists of a special probe mounted in the six-inch generator outlet line, a stainless steel water-cooled sample conditioner with a steel release trap, filter, pressure reducer and regulator. Since the sample stream is steam-saturated at 400 psig, the sample conditioner is made of welded steel.

An outside water jacket cools the sample and condensate collects in the bottom of the tower. As condensate builds up, it causes the trap to open and steam pressure forces the condensate out.

Infra-Red Analyzer

In addition to monitoring methane in generator effluent, infra-red analyzers are used elsewhere in the plant to measure carbon monoxide, carbon dioxide, etc.

The unit consists of two infra-red light sources, a sample cell and a comparison cell both made from stainless steel, a V-shaped beam combiner, a detector cell, an amplifier and a recorder. A shutter alternately blocks each beam to the sample and comparison cells, permitting comparison of the amount of light reaching the detector through the two cells.

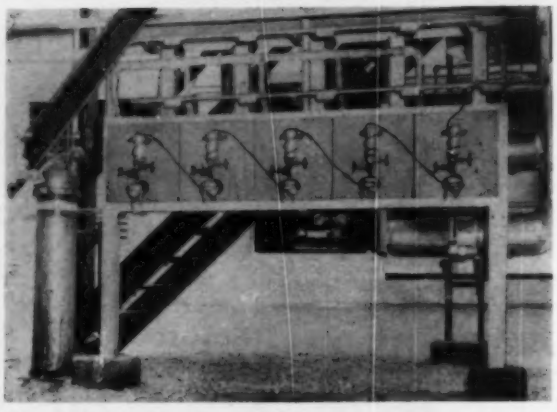

FIG. 1. **Sampling system used at the Selma, Missouri, ammonia plant** of Mississippi River Fuel Corporation. The analyzers and sampling systems are immediately beneath the generators.

Unbalance between the two beams is measured by the detector this way: An expansion chamber in the detector cell is filled with the gas or vapor which is to be measured and a small diaphragm is mounted above the chamber. The diaphragm is one plate of an electrical condenser; as the gas in the chamber expands or contracts it causes the diaphragm to deflect, creating an electrical impulse which is amplified and fed to a recorder.

The gas in the chamber expands when exposed to infra-red light of the right frequency and contracts when the light is removed or lessened. As long as the light beams through the sample and comparison cells are the same, there is no movement. However, when one of the light beams is weakened by some absorption in the sample cell the diaphragm is deflected according to amount of absorption and an electrical impulse generated.

Null Balance Principle

The null balance principle of operation is incorporated in the infra-red analyzer system. Output of the infra-red detector cell is electrically amplified to provide the energy necessary to operate a balancing motor which repositions a helipot used to control the voltage on one of the infra-red sources. The balancing motor also drives the recording pen and indicating pointer of the recording potentiometer.

Acknowledgment

The information and photographs for this article were provided by Mine Safety Appliances Company, Pittsburgh, Pennsylvania.

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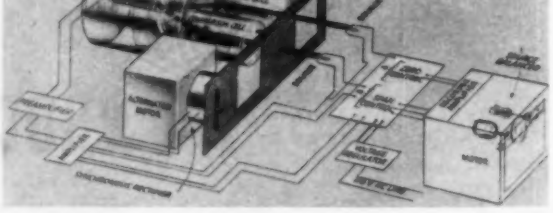

FIG. 3. **Infra-red analyzer** is set up to measure unbalance between two beams of light, one through a sample cell and one through a comparison cell.

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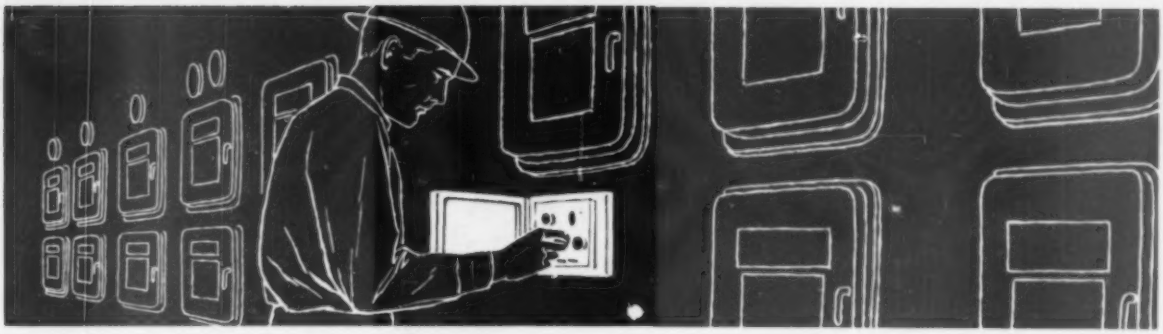

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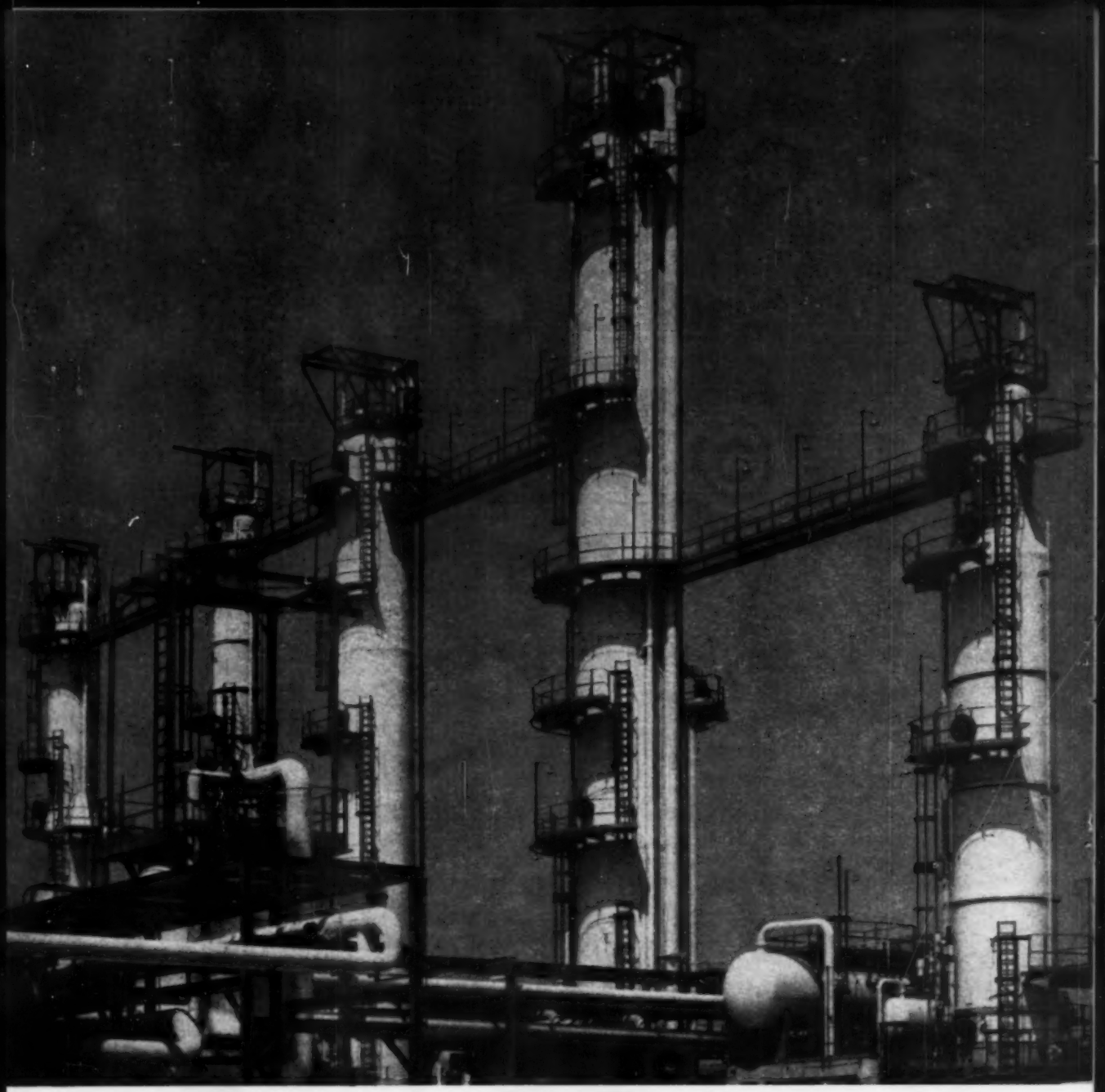

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Fig. 1793 — Large Iron Body Bronze Mounted Gate Valve for 125 W. S. P. Outside screw rising stem and yoke, solid wedge disc. 8" and larger valves can be supplied with split wedge disc. Also available in all iron.

Fig. 559 — Large High Test Iron Body Bronze Mounted Swing Check Valve for 125 W. S. P. Heavily bolted iron cap. Renewable bronze seat rings, discs or disc facing, disc hinges. Can be used in horizontal or vertical position. All iron valves also available.

Fig. 1503 — Steel Gate Valve for 150 pounds. Outside screw rising stem. Heavily bolted bonnet and yoke. Precision fitted, accurately guided solid wedge disc. Valves with welding ends can also be supplied.

Fig. 1460 — "Master Pilot" Gate Valve for 150 W. S. P. Iron body bronze mounted. Bolted flanged bonnet with inside screw rising stem, solid wedge disc. Can also be furnished with flanged ends, and in all iron.

Fig. 8150 — Bronze L. P. Gas Globe Valve for 400 W. O. G. Union bonnet, inside screw rising stem, special composition disc, integral seat. Listed by Underwriters' Laboratories, Inc. Angle, Gate, Lift Check and Steel Valves available.

Fig. 1559 — Steel Lubricated Plug Valve for 200 pounds W. O. G.—A. S. A. 150 pounds. Screwed gland type. Single gland and bolted gland types can also be furnished. Large Valves—6" and above, can be supplied with gears for gear operation.

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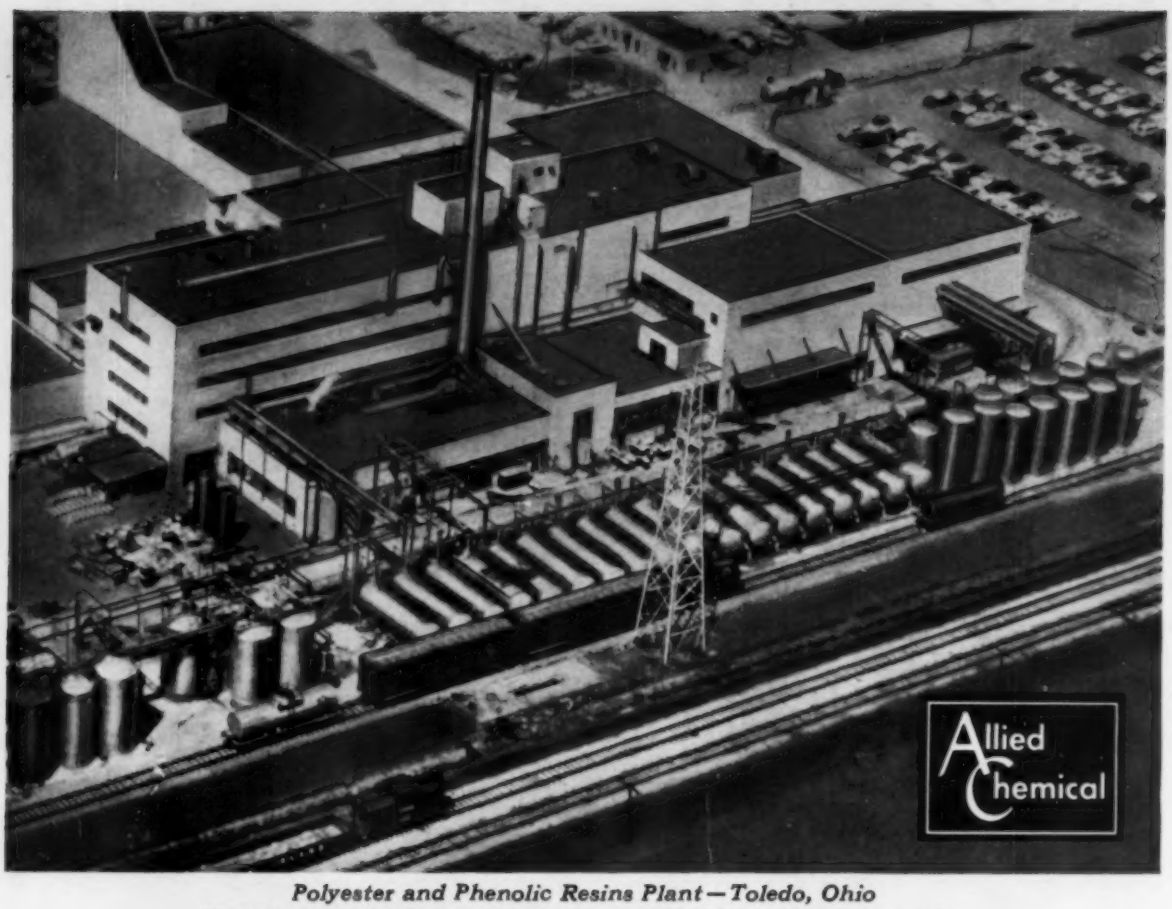

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Udex® Extraction for Aromatics Recovery

Licensed by: Universal Oil Products Company

DESCRIPTION: The Udex process is a selective liquid-liquid solvent extraction method for separation and purification of aromatics from hydrocarbon mixtures. Originally developed to recover high-purity aromatics from catalytic reformates, Udex has also been applied to aromatic recovery from light oils by-produced in coke ovens, from thermal aromatic concentrates such as ethylene co-product light oil fractions, and other aromatic-rich products. Most installations recover BTX; however, heavier aromatics and dicyclics can also be recovered in high purity.

Referring to the flowsheet, hyrocarbon feed is charged to an intermediate point in the liquid-phase extractor tower. Hydrocarbon condensate from the stripper overhead flows into the bottom of the extractor as reflux. Lean solvent enters at the tower top. Enriched solvent from the bottom of the extractor is flashed in the top of the stripper because of reduction in pressure.

Liquid flows down the stripper, where dissolved hydrocarbons are removed as vapors generated by a reboiler. Water layers from the stripper overhead and product receivers are combined and recycled to maintain composition of the extracting solvent.

Aromatic extract withdrawn as a sidestream from the stripper is cooled and washed with water, and is sent either to intermediate storage or direct to clay treatment. Raffinate, which is almost completely paraffinic, leaves the top of the extractor, is cooled, water-washed with effluent water from the extract washer, and sent to storage.

The extract may contain traces of unsaturates, limiting the purity of the final products, and traces of residual non-hydrocarbon compounds, which would spoil the acid-wash color test of the final products. To destroy these trace impurities, the extract is processed through a clay bed before final distillation.

Redistillation of the product takes place in three successive columns, making pure benzene, toluene and C_8 aromatics, respectively, as overhead products, and C_9 + aromatics as a bottoms product of the xylenes column. No intermediate cuts are necessary.

Recoveries are in the order of:
Benzene — 99 + Vol %
Toluene — 95 + Vol %
Xylenes — 90 + Vol %

ESTIMATED YIELDS:

	160-300°F Boiling Range Catalytic Reformate	
Feed		
Benzene	300 BPSD	6 Vol %
Toluene	800	16
Xylenes	900	18
non-Aromatic	3000	60
TOTAL	5000 BPSD	100 Vol %
Products		
Raffinate	3132 BPSD	62.6 Vol %
Benzene	298	~6.0
Toluene	760	15.2
Xylenes	810	16.2

ESTIMATED CHEMICAL AND UTILITY REQUIREMENTS FOR FACILITIES SHOWN IN THE FLOW SHEET

Catalytic Reformate 5000 BPSD	
Steam,* (150 psig), #/hr.	56,000
Electricity KW	335
Cooling Water (30°F. rise) GPM	3,500
Fuel Gas, MM Btu/hr.	2.0
Clay, #/day	900
Process Water, B/D	300
Glycol, #/day	750

*Fuel gas can be used instead of steam.

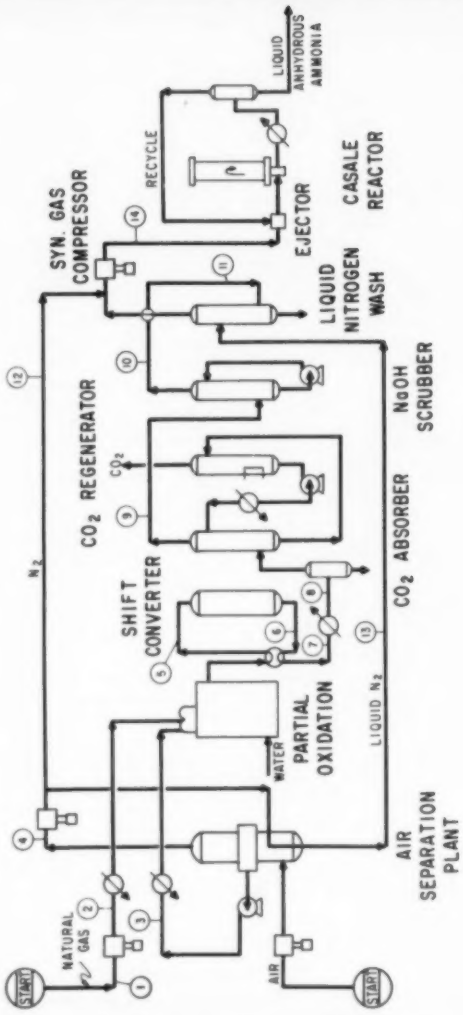
OPERATING PERSONNEL: Two men/shift

OPERATING COSTS AND INVESTMENT:

Based on a unit processing 5000 BPSD of catalytic reformate, operating cost is estimated at 3.5¢ per gal. of aromatics recovered, or $2594 per CD, assuming 350 SD/yr. This includes $995 direct operating costs, $748 fixed overhead, and $851 daily capital charges. Investment, Gulf Coast basis, would be $1,300,000, for the 5000 BPSD unit, as shown in the flow sheet, recovering 1868 BPSD of aromatics. Adding fractionation facilities for production of benzene, toluene, and xylenes as individual high purity streams will increase investment approximately $500,000.

Ammonia Synthesis

Designed by: Foster Wheeler Corporation



OPERATING CONDITIONS:

Point	°F	psig
1	60	100/175
2	260	410
3	40	400
4	45	-0-
5	700	300
6	750	280
7	350	280
8	100	280
9	100	280
10	100	275
11	40	270
12	100	315
13	—300	200
14	100	9,000

Ammonia Synthesis

Designed by: Foster Wheeler Corporation

DESCRIPTION: This process combines several proved processes to make ammonia from nitrogen (air) and hydrogen derived from hydrocarbons. The flow diagram shown is for use of methane as the hydrogen source; however, modifications are possible so that any hydrocarbon, including fuel oil, could be used.

The plant is divided into six sections, described below.

1. Air Fractionation Plant—Caustic washed air is compressed to 600 psig, cooled and fractionated into oxygen and nitrogen streams. The oxygen is heated before it meets the natural gas at the synthesis gas generator. The nitrogen stream is used, of course, in the ammonia synthesis reaction.

2. Synthesis Gas Generation — The Texaco process is used to partially oxidize the natural gas to carbon monoxide and hydrogen.

3. Shift Converter—Water-quenched products are reheated and charged to a shift converter where more hydrogen is generated and CO is converted to CO_2.

4. CO_2 Removal — Monoethanolamine is used to extract the CO_2 from the shift converter products, yielding an essentially pure stream of hydrogen.

5. Liquid Nitrogen Wash—Caustic-washed and dried gas from the CO_2 removal section is washed with liquid nitrogen to condense and remove any unconverted methane, carbon monoxide and other impurities.

6. Ammonia Synthesis—The Casale process is used to process the mixture of gaseous hydrogen and nitrogen. The incoming gas is compressed to 9,000 psig, cooled to 100 F. The tubular reactor, cooled to remove heat of reaction, catalytically converts the stream to ammonia.

UTILITIES:

	Unit	per Ton Ammonia (1)	(2)	(3)	(4)
Fuel Gas	MSCF	.9	.9	7.8	10.9
Steam 400 psig	Lb	4650	8700	8700	4650
Steam 50 psig	Lb	—	580*	580*	—
Cooling Water 80 F	M/gal	78	95	102	85
Electric Power	KWH	1120	925	58	65

(1) Compressors — Electric-driven reciprocating.
(2) Compressors — Turbo-centrifugal and motor-driven reciprocating.
(3) Compressors — Turbo-centrifugal and Gas Engine-driven reciprocating.
(4) Compressors — Gas Engine-driven reciprocating.

*Low-pressure Steam returned to unit limits.

RAW MATERIAL, CHEMICALS AND CATALYSTS:

FEED GASES	Unit	Per Ton Ammonia
Natural Gas (1080 BTU/SCF)	MSCF	26.20
CATALYSTS		
Shift Reaction	Lb	.23
Ammonia Synthesis	Lb	.125
CHEMICALS		
Caustic Soda	Lb	11.75
MEA (monoethanolamine)	Lb	.40

OPERATING PERSONNEL — Five to six men per shift.

INVESTMENT (U. S. Gulf Coast, 1957 Basis, Battery Limits Plant)

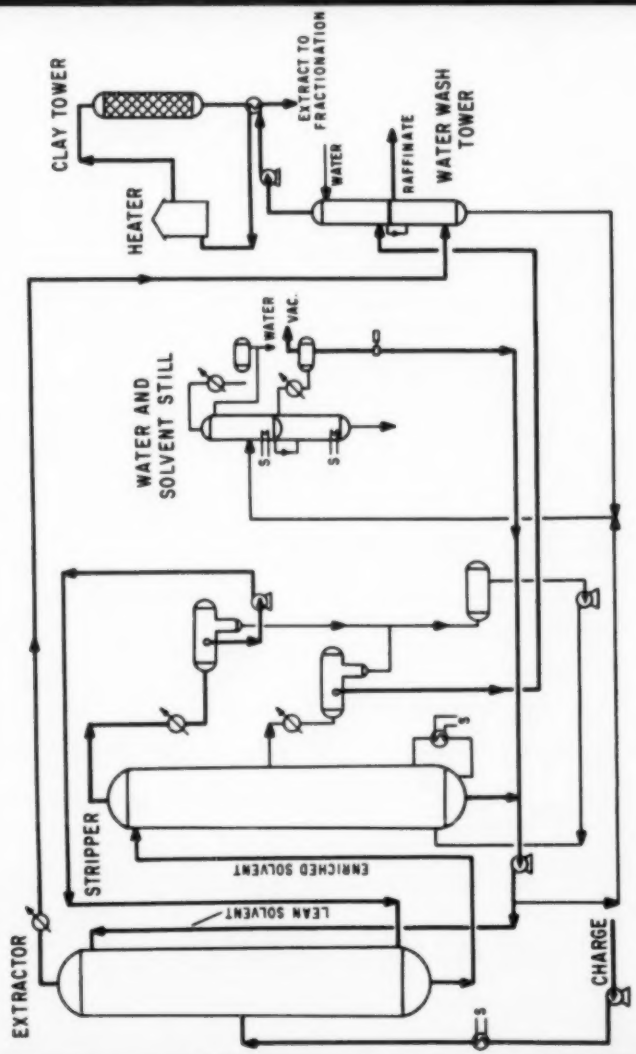
Capacity, T/D NH_3	MM $
50	3.5 - 4.0
100	4.5 - 5.5
200	6.5 - 7.5

ANNUAL MAINTENANCE:

Materials, supplies and labor: Approx. 3% of initial investment.

Udex Extraction for Aromatics Recovery

Licensed by: Universal Oil Products Company



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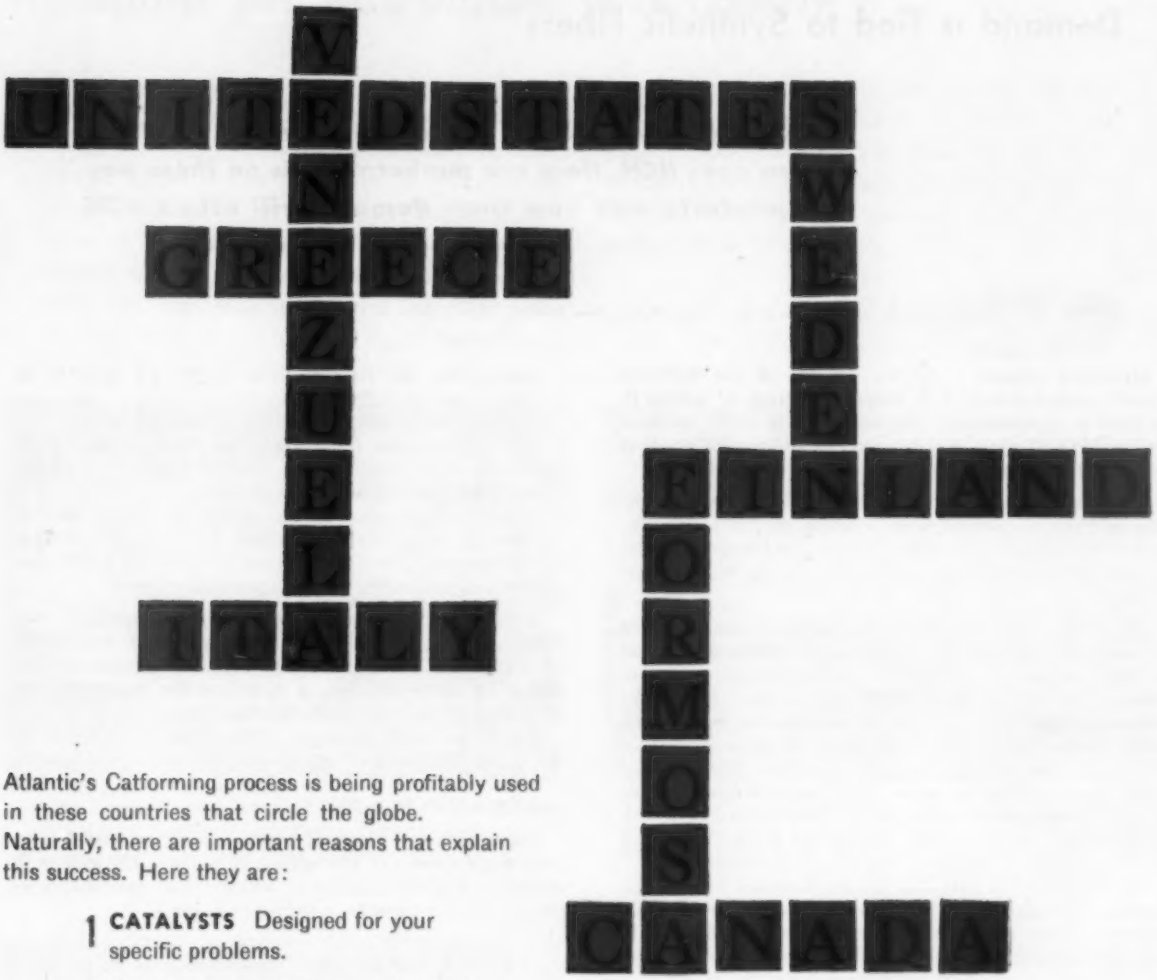

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First of three chapters on a growth petrochemical . . .

. . . Hydrogen Cyanide:

Demand is Tied to Synthetic Fibers

As goes acrylonitrile, adiponitrile and the acrylates so goes HCN. Here are market reports on these key products, and how their demand will affect HCN

Peter W. Sherwood, *Chemical Engineer, White Plains, New York*

Hydrogen cyanide . . . HCN . . . is one of the strongest growth petrochemicals. U.S. output rose from 40 million lb in 1948 to approximately 140 million lb in 1957. Increase during 1955-57 alone was 51 percent! Indications are that 1958 production of HCN will be close to 160 million lb.

Primary outlets for petrochemical HCN . . . most important production method is by reacting methane and ammonia, with or without addition of air . . . are in the synthesis of acrylonitrile, adiponitrile, and acrylate and methacrylate resins.

The lion's share of current production is consumed in synthesis of acrylonitrile, accounting for 60 to 65 percent of HCN output. Adiponitrile . . . in second place . . . consumes 20 to 22 percent of HCN production. Most of the remainder goes into manufacture of acrylate and methacrylate resins. Several other chemical products depend on HCN as an intermediate, too. Among them are indigo and vinylidiene cyanide, the latter a monomer which is on the verge of commercial utilization in manufacture of a synthetic fiber. Finally, a small but steady market exists for HCN as fumigant, pesticide, and chemical intermediate.

HCN's growth is tied strongly to expansion in synthetic textiles, through the nitriles of acrylic and adipic acid . . . and vinylidiene cyanide. Manufacture of nylon 6/6 and 6/10 constitutes the only important market for adiponitrile. For acrylonitrile, acrylic fiber production accounts for some 70 percent of demand.

To gage outlook for HCN, it is therefore necessary to look at the prospects for its chemical derivatives and the polymeric end products.

ACRYLONITRILE . . . Dependence on Synthetic Fibers a Recent Development

As recently as 1950, synthetic fibers manufacture consumed a mere two million lb acrylonitrile annually. In 1957, this market required an estimated 110 million lb!

Nitrile rubber led acrylonitrile consumption only five years ago, takes up only 16 percent of today's output. But, this still accounts for about 16 million lb HCN annually. Following a war-time peak of approximately 15,000 long tons in 1944, nitrile rubber production dropped to 6618 LT in 1947. It has since made good recovery, with output at 21,396 LT in 1954 and 32,982 LT in 1957. Keeping pace with expanding demand, U.S. production capacity for N-type rubber was boosted from 37,000 LT in 1955 to 64,000 LT per yr at the end of 1957.[1]

Demand for N-type rubber is of specialty nature . . . it is used chiefly where resistance to oil, heat or chemicals is important. Chief markets are thus in mechanical rubber goods, paper treatment, auto and airplane parts.

Indications are that future growth of nitrile rubber demand will be more moderate than during the early 1950's. One promising future area is for use as binder for non-woven fabrics and in treating of wash-and-wear clothes.[2]

Acrylonitrile's future is geared mainly to textiles, since nitrile rubber growth is only at moderate level. Production of synthetic fibers is paramount here, but promise is also shown by cynoethylation, a technique for modifying the properties of natural fibers, notably cotton.

The great strides made in acrylic fibers are reflected in the rapid expansion of manufacturing facilities. Capacity rose from nil in 1950 to 120 million lb per yr in early 1957 and 230 million lb in 1958.[3]

Capacity is well ahead of needs . . . a recent study[5] forecasts requirements of 170 million lb in 1960, 250 million lb annually in 1965. Line-up of acrylate fiber manufacturers and their plant capacity is shown in Table 1.

TABLE 1. Acrylate Fiber Manufacturers in the U. S.

Producer	Fiber Trade Name	Estimated Plant Cap'l, Late 1958 (Million lb/yr)	Plant Location
American Cyanamid	Creslan	27	Pensacola, Florida
Carbide & Carbon	Dynel	8	S. Charleston, West Virginia
Chemstrand	Acrilan	45-50	Decatur, Alabama
Dow Chemical	Zefran	15	Lee Hall, Virginia
Du Pont	Orlon	120	Camden, South Carolina and Waynesboro, Virginia
Tennessee Eastman	Verel	12	Kingsport, Tennessee

Acrylate fibers vary widely in composition. But, acrylonitrile constitutes a high percentage of the polymer's struction in all. Dynel is reportedly a 40/60 copolymer of acrylonitrile and vinyl chloride. Zefran is said to be made by wet spinning an acetone solution of a 40/60 copolymer of acrylonitrile and vinylidiene chloride.

Polyacryonitriles such as Orlon and Acrilan contain in excess of 85 percent acrylonitrile. Consumption of the monomer for Orlon is said to be one pound per pound[4] and one pound of Acrilan uses 0.85 lb acrylonitrile . . . plus

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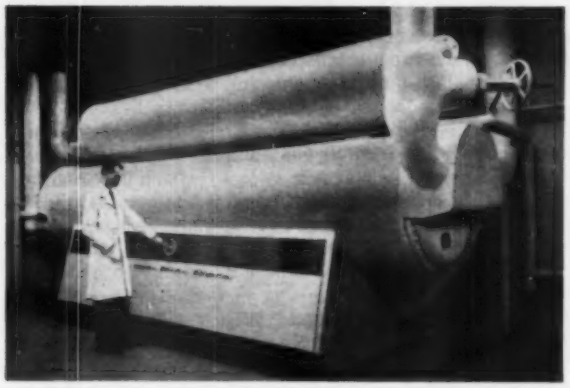
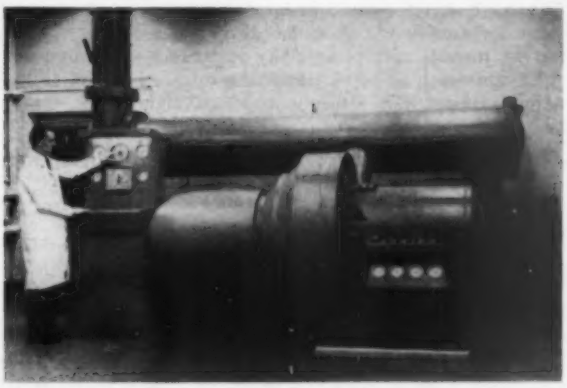
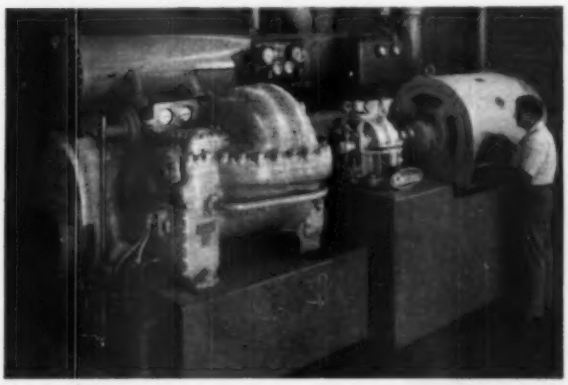
Carrier



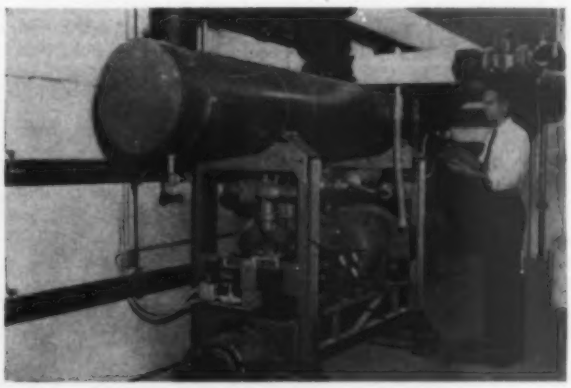
If you have low-cost steam, Carrier's new Absorption Refrigeration Machines may be best. They use heat energy from low-pressure steam, hot water, hot petroleum or other solutions. They're dependable, efficient. Operation is automatic and quiet. Cooling capacities: 60 to 700 tons.



If you have low-cost electricity, new Hermetic Centrifugal Refrigeration may be the answer. Compactness and light weight minimize space and structural requirements. Electronic controls provide continuous, automatic chilling of water to the desired temperature. From 90 to 1100 tons.



If the load is large, Carrier Centrifugal Refrigerating Machines may be best. With capacities to 4000 tons, they can serve the largest applications with accurate, automatic control of temperature 24 hours a day, year around. Extremely versatile, they can be used for many processes.



If the load is small, Carrier Reciprocating Water Cooling Machines may be ideal. They're completely "packaged." Installation costs are lower and operation more efficient than units assembled from unrelated components. Their cooling capacities range from 3 to 200 tons.

0.15 lb vinyl acetate and a small amount of vinyl pyridine.

Four producers supply U.S. requirements for acrylonitrile. These producers and their reported capacity are shown in Table 2. A fifth firm, The Dow Chemical Company, plans to initiate acrylonitrile production in mid-1959.

TABLE 2. Producers of Acrylonitrile in the U. S.

Producer	Plant Capacity (Million lb/yr)	Location
American Cyanamid	100	Fortier, Louisiana
Union Carbide	70	Institute, West Virginia
B. F. Goodrich	24	Calvert City, Kentucky
Monsanto	100	Texas City, Texas

Acrylonitrile is obtained by the direct reaction of acetylene with hydrogen cyanide at all these plants. (The last plant which employed the indirect route, based on HCN plus ethylene oxide, was shut down in late 1957.

Furthermore, all these firms produce hydrogen cyanide captively. The chosen route is the partial combustion of methane in the presence of ammonia, which will be discussed in the next chapter.

While production of acrylate fibers overshadows other uses for acrylonitrile, a relatively new technique for modifying natural fibers is gaining ground as acrylo consumer. This method, referred to as cyanoethylation, is of proved value for modifying cotton, has also shown definite potential for manufacture of specialty paper and jute products. As a consumer of acrylonitrile, the cyanoethylation technique is of potential rather than present significance.

ADIPONITRILE . . . Second-Largest HCN Consumer

Demand for adiponitrile is tied to production of nylon. Here, adiponitrile is used as an intermediate in hexamethylene diamine production.

Two major routes are used to make the nitrile. In one of these, adipic acid and ammonia are the raw materials. In the other, which is of interest as HCN consumer, butadiene is the organic base stock. The method involves chlorination to 1, 4-dichlorobutene-2 which is reacted with HCN to yield 1,4 dicyanobutene-2. A hydrogenative step converts this intermediate to adiponitrile. For details of this process, see Ref. 6.

Production of adiponitrile is split about equally between these two methods of synthesis. The butadiene-based process will have consumed an estimated 40 million lbs of HCN during 1958.

Adiponitrile is hydrogenated to form hexamethylene diamine. This intermediate enters the synthesis of nylon-6/6 and nylon 6/10, the two types which make up the overwhelming bulk of U.S. output. In the more important type, nylon 6/6, hexamethylene diamine is copolymerized with adipic acid. Consumption is 0.554 lbs HMDA per lb of the polymer. Nylon 6/10, produced on a much smaller scale, is a copolymer of hexamethylene diamine and sebacic acid.

Nylon capacity in the United States was 350 million lbs in 1957, almost entirely devoted to the manufacture of the above two types. An active expansion program will have raised capacity to 450 million lbs per yr by the end of 1958. However, much of the new capacity will be directed at the production of nylon-6, a polymer which is based on caprolactam rather than adiponitrile.

Total outlook for production of nylon fibers (all types) has been forecast at 340 million lbs in 1960, 450 million lbs in 1965.

While textile fibers constitute the main use of nylon polymers, some nylon market exists in the manufacture of plastics. This outlet . . . which was about four percent of 1957 production . . . currently shows a good uptrend.

VINYLIDIENE CYANIDE . . . A Promising Newcomer

The technical importance of vinylidiene cyanide rests in manufacture of dinitrile polymer fibers (B. F. Goodrich Company's "Darlan"). Production of this fiber is now getting underway with operation of a new 30 million lbs-per-year plant.

Route of manufacture has not been disclosed, but there are two useful methods of synthesis, both of which employ HCN as one of the raw materials. The more promising of these approaches involves pyrolysis of 1-acetoxy-1, 1-dicyanoethane, a derivative of hydrogen cyanide and ketene or acetic anhydride.

METHACRYLATES . . . Recent Growth Has Been More Rapid

Methacrylate esters are produced via acetone cyanhydrin, an addition compound of acetone and hydrogen cyanide. Largest single use for these esters is as monomer in the manufacture of polymethacrylate plastics. In addition, methacrylate polymers serve as oil additives . . . viscosity index improvers . . . and in lacquer and paint formulations.

Consumption of methacrylate monomer in 1957 was about 75 million lbs. Of this, some 12 million lbs went into surface coatings (methacrylate latex paints) and an estimated 55 to 60 million lbs appeared as polymethacrylate sheet and molding powders.

In both these fields, production was thus well above the 1956 level when plastics accounted for somewhat less than 50 million lbs and latex paints for some 5 million lbs of methacrylate monomer output.

The long-term growth history of polymethacrylates has been more moderate. The 1952 output of polymethacrylate plastics has been estimated at 30 to 40 million lbs, about the same as during the latter years of World War II, but 10 million lbs above the level of 1949, a slump year.[7] One forecast predicts that monomer volume will reach 100 million lbs by 1961 or 1962.[8]

There are three producers of methacrylate esters in the U.S. Du Pont's plant at Belle, West Virginia, has an estimated capacity of 50 million lb per year. The new Hawthorne Chemical Company . . . jointly owned by Hercules Powder and Imperial Chemical Industries . . . plant at Louisiana, Missouri, will have an (announced) capacity of 35 million lb per year. The Rohm & Haas plant at Deer Park (Houston), Texas, capacity is estimated to be 60 to 75 million lb annually.

Acrylate esters are chemically related to the methacrylates and HCN once figured prominently in their manufacture. But, the HCN-based process, which provided for methacrylates manufacture via ethylene cyanhydrin, is now largely superceded by synthesis from carbon monoxide, acetylene and ethanol or methanol.

Summing up, overall outlook is for considerable growth in demand for hydrogen cyanide. This will be sparked principally by rising output in acrylate fibers. It is expected that essentially all new HCN capacity requirements will be met by petrochemical processes, in which ammonia and methane serve as the raw materials.

"Autothermic Synthesis of Hydrogen Cyanide" will be described in the next part of this article, to appear in a future issue of *The Refining Engineer.*

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For purification, fractionation, and catalysis . . .

Ion Exchange

—Versatile Process Tool

J. W. Churchman
The Dow Chemical Company
Midland, Michigan

ION EXCHANGE has become accepted as a unit operation in chemical processing within the past 15 years. Considered by many to belong only in the field of water purification, ion exchange can now be compared with such unit operations as distillation, fractional crystallization and solvent extraction, in many areas of process application.

Chemical processing applications include purification, fractionation, and catalysis. Proposed uses include removal of copper from gasoline, and extraction of sodium soaps from acid treated or neutralized oils. Elimination of acidic compounds, such as mercaptans, from petroleum distillates, removal of caustic from alcohol and acid from glycol are among other uses proposed for ion exchange resins. Removal of phenolic and nitrogen compounds from petroleum distillates has also been studied.

Purification via Ion Exchange

Purification is the major area of application for ion exchange. It can be divided into two categories, (1) removal of cations or anions and neutralization, and (2) deionization.

Ion removal and neutralization. As mentioned above, ion exchange has been suggested as a method for removing copper from gasoline[4] and for removing sodium soaps from acid treated or neutralized oils.[5] Removal of traces of iron from concentrated hydrochloric acid can be done by contacting the acid with the chloride form of a strongly basic anion exchange resin.

Since cation exchange resins in the hydrogen form, and anion exchange resins in the hydroxide form are comparable to aqueous solutions of strong acids and bases, respectively, they may be used to neutralize undesirable acidic or basic components in a product. These reactions show how ion exchange neutralization parallels ordinary chemical neutralization:

$$Na^+ OH^- + RSO_3^- \rightarrow RSO_3^- Na^+ + HOH$$

$$H^+ Cl^- + R^+ OH^- \rightarrow R^+ Cl^- + HOH$$

Examples of ion exchange neutralization would include removal of caustic from alcohol, acid from glycol, and formic acid from formaldehyde. Laboratory studies have shown that nonvolatile acids such as thiocyanic acid and formic acid can be economically removed from diethanolamine solutions used in gas treating.[6] Use of strongly basic anion exchange resins has been considered for elimination of acidic compounds such as mercaptans from petroleum distillates.[7-12] Removal of phenolic compounds[13] and nitrogen compounds[14] by ion exchange methods has been studied, too.

Deionization

Deionization utilizes a combination of anion and cation exchange resins to remove all ionic impurities from a product. Thus, if the ionic contaminant were NaCl, it could be converted to HCl by contacting it with the hydrogen form of a cation exchanger:

$$Na^+ Cl^- + RSO_3^- H^+ \rightleftarrows H^+ Cl^- + RSO_3^- Na^+$$

The second step of the deionization would be to neutralize the HCl produced by use of the hydroxide form of an anion exchanger as shown previously. Among the products purified by ion exchange deionization are sucrose and glycerine.

Fractionation

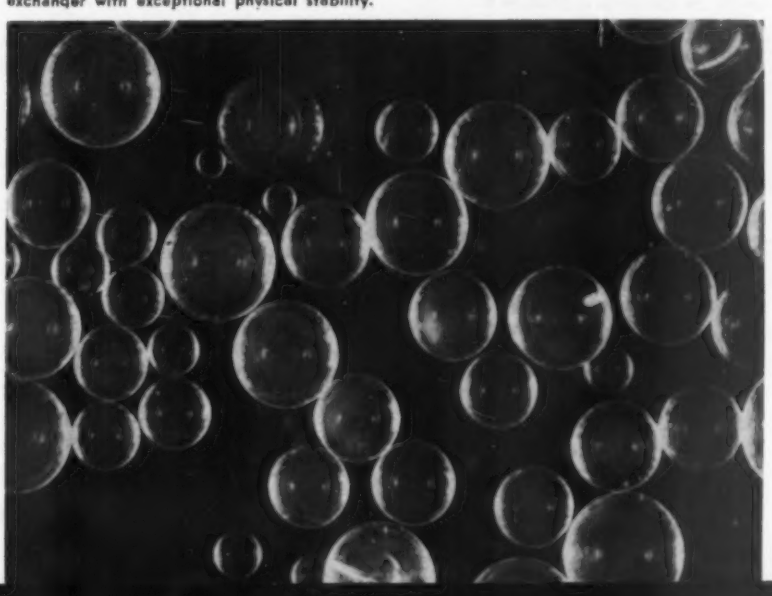
Ion exchange fractionation . . . or chromatography . . . is mainly an analytical tool used in separating similar ionic species. But, in at least one application, separation of rare earths,[1] it has attained commercial significance. Laboratory uses include separation of similar amino acids and alkaline earth metals.

Catalysis

Since ion exchange resins may be considered as insoluble acids or bases, they may be expected to promote reactions catalyzed by aqueous solutions of acids or bases. Most of these aqueous-type reactions have been studied using corresponding ion exchange resins.[1,3,15] Results obtained compare favorably, in general, with those secured by conventional catalysis.

An ion exchange-catalyzed reaction which has created wide recent interest is the epoxidation of fatty oils, using the hydrogen form of a sulfonic cation exchange resin as the catalyst. In this reaction, peracetic acid can be formed

FIG. 1. **Photomicrograph of a synthetic organic ion exchange resin.** These resins can be visualized as an elastic, three-dimensional hydrocarbon network to which are attached a large number of ion-active groups. Most ideal network to date is that formed by the copolymerization of styrene and divinylbenzene. Resin illustrated is Dowex 50W, 20-50 mesh, a sulfonic action exchanger with exceptional physical stability.



		STRONG OR SALT-SPLITTING RESINS	WEAK OR ADSORBING RESINS
CATION EXCHANGE RESINS	Classification	SULFONIC ACID RESIN	CARBOXYLIC ACID RESIN
	ION ACTIVE GROUP	$RSO_3^-H^+$	RCOOH
ANION EXCHANGE RESINS	Classification	QUATERNARY AMMONIUM RESIN	AMINE RESIN
	ION ACTIVE GROUP	$RR'_3N^+OH^-$	RNH_2, $RNR'H$ or RNR'_2

FIG. 2. **The major types of ion exchange resins.**

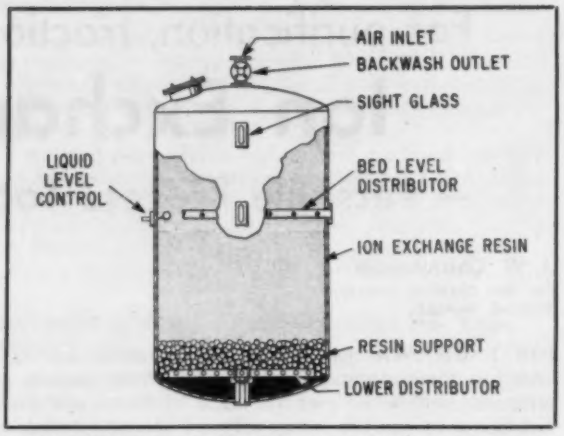


FIG. 3. **Typical pneumatic dome ion exchange unit used in chemical processing.**

in-situ or preformed. It proceeds to react with the unsaturated bonds in the fatty oils to introduce the epoxy linkage.

Advantages of ion exchange catalysts are:

1. Ease of catalyst separation after reaction completion.
2. Neutralization of the reaction mixture is not required.
3. Substantial reduction or complete elimination of side reactions is possible.
4. Cost reduction because the catalyst may be used repeatedly, in many instances without regeneration.
5. Increased product yield may be obtained.
6. Volatile products may be distilled from the resin with little or no charring.
7. Acid catalysis corrosion problems are reduced.
8. Reactions in which the product is sensitive to acid or base may be performed because the product can be removed rapidly from the catalyst.

Major disadvantages of ion exchange resins as catalysts appear to be:

1. Thermal limitations . . . normally, 150 C is the maximum thermal limit recommended for polystyrene-based cation exchange resins and for strong base resins in other than the hydroxide form, while 50 C or less is suggested for use of strong base anion resins in the hydroxide form. Such thermal limitations are admittedly somewhat arbitrary and should not preclude evaluations at higher temperatures.
2. Physical and mechanical limitations placed on the use of ion exchange resins.

Non-Aqueous Ion Exchange

Operation in an aqueous medium is commonly associated with ion exchange. However, some of the applications mentioned, such as removal of caustic from alcohol and acid from glycol indicate that non-aqueous ion exchange is feasible. Although an aqueous medium is the most efficient, use of other media is definitely practical in many applications.

Polar solvents will support ion exchange more efficiently than will hydrophobic media, but the previous examples such as mercaptan removal from petroleum distillates indicate that practical exchange reactions can be obtained in hydrophobic media. In addition, a small amount of water added to the organic medium will greatly improve operating efficiency. This can be illustrated by comparing rate of hydrogen ion exchange in dry acetone as compared to acetone-water mixtures[10]:

Solution	Relative Exchange Rate
Acetone	0.007
98:2 acetone-water mixture	2.0
90:10 acetone-water mixture	5.0
Pure water	19.0

Ion Exchange Equipment

Construction of a typical chemical processing ion exchange unit is shown in Fig. 3. This unit uses a pneumatic dome to keep the liquid level just above the top of the resin bed. This controls dilution and properly introduces liquid to ensure minimum back mixing of liquid components within the unit.

Pipe lateral systems evenly distribute feed solutions over the entire cross sectional area of the bed, a very important factor in large diameter units. Resin support is usually graded gravel or coal fines. Corrosion resistance may be obtained for the unit and its auxiliaries by proper choice of construction metals or coating materials such as hard rubber or phenolic resins.

Auxiliary apparatus may include regenerant storage tanks, external piping, and flow meters for feed and regenerant solutions. In addition, pH, conductivity or density meters may be used to determine when the bed is exhausted.

A commercial ion exchange unit may be operated manually, semi-automatically, or fully automatically. In semi-automatic operation, one step such as regeneration will be automatic and the rest of the cycle manual. In commercial fixed-bed units, it is common to use two beds so that one can be regenerating while the other is being exhausted.

Development of practical continuous ion exchange units is being given consideration by numerous groups. In such units, resin would be moved constantly or intermittently through the system, with regeneration and exhaustion occurring simultaneously in different parts of the unit.

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★ ★ ★

This $25-million plant is the largest single supplier to the new Trans-Canada pipeline:

The Pincher Creek Gas Processing Plant

British American Oil's new Pincher Creek, Alberta, gas processing plant is now in full operation, as the largest single gas supplier to the new Trans-Canada pipeline. It's expected that the big plant . . . feed gas capacity is 120 MMcf per day with provision made for expansion . . . will send an average of 70 MMcf daily to the line during the first year.

Initial daily capacity for natural gas-derived products at the $25 million plant is 25,000 gal of propane, 40,000 gal of butane, 450 long tons of sulfur, and an undisclosed amount of condensate.

The plant was built in two stages, with Stage 1 completed in January 1957, to recover only condensate and sulfur from 60 MMcf of gas daily. Partially processed gas was returned to the wells, awaiting completion of the Trans-Canada pipeline. The Stage 2 plant went onstream in October 1958, providing a complete processing facility to serve one of Canada's largest gas fields. Pincher Creek is a sour gas field, as are about 50 percent of the proved gas reserves in Western Canada.

Gas Sweetening and Dehydration

Free liquids are separated from the gas at about 1200 psig at the wells. Separate lines deliver gas to the plant at 1000 psig and liquid at 500 psig.

Two inlet separators, each rated at 120 MMscf per day, remove condensate from the gas prior to treating in four high-pressure amine units. A 20 percent MEA solution is used for H_2S and CO_2 removal. Sweetened gas then passes through the main absorber to recover propane and heavier constituents. Residue gas is scrubbed to remove traces of absorption oil, then dehydrated.

Two solid desiccant dehydrators are used to reduce water content to four pounds per Mcf, maximum. One dehydrator is always on the line, with the other on the regeneration cycle. Dehydrated gas is metered and flowed through a pressure control station set at 900 psig, maximum. Alternately, gas can be taken from the dryers to suction of the injection compressors for reinjection into the field.

Condensate Processing

Liquid phase from the well passes through separators into a stabilizer to remove butane and lighter components.

Vapor from the inlet separator is processed in a 500 psig MEA contactor, while overhead vapors from the condensate stabilizer pass through a 125 psig MEA contactor to remove acid gases. Sweet gas from these two contactors are processed in the reabsorber and demethanizer, respectively, dried in a glycol unit, and used as fuel to the plant and field facilities.

Liquid Products Processing

Rich absorption oil is demethanized, then pumped through a direct-fired heater to the main still. Lean absorption oil is cooled and returned to the absorbers.

A lean oil still processes stabilized condensate and a slip-stream from the main still to make a 450/550 F, high M.W. lean oil for makeup purposes and to purge high-boiling components from the lean oil.

Overhead from the main still is washed with 10 percent caustic to remove mercaptans. Mercaptans are flared after being steam-stripped from the caustic in a regenerator. The hydrocarbon product passes through a sand filter to remove entrained caustic and water, and then goes to the fractionation section. Fractionation facilities consist of the deethanizer, depropanizer, debutanizer, and other associated equipment.

Sulfur Recovery

Rich amine from the bottoms of the contactors collect in a rich solution vent tank, where dissolved hydrocarbons are flashed off and flow to the boiler fuel system. The amine solution is heated and stripped of H_2S and CO_2 by heat supplied from steam-heated reboilers. Regenerator overhead gas is condensed to remove water, providing acid gas which is charged to the sulfur recovery plant.

There are three basically identical sulfur recovery units at Pincher Creek, each able to produce 225 long tons of sulfur daily. The acid gas is partially oxidized to SO_2 which is then reacted with the remaining H_2S over a catalyst to make free sulfur.

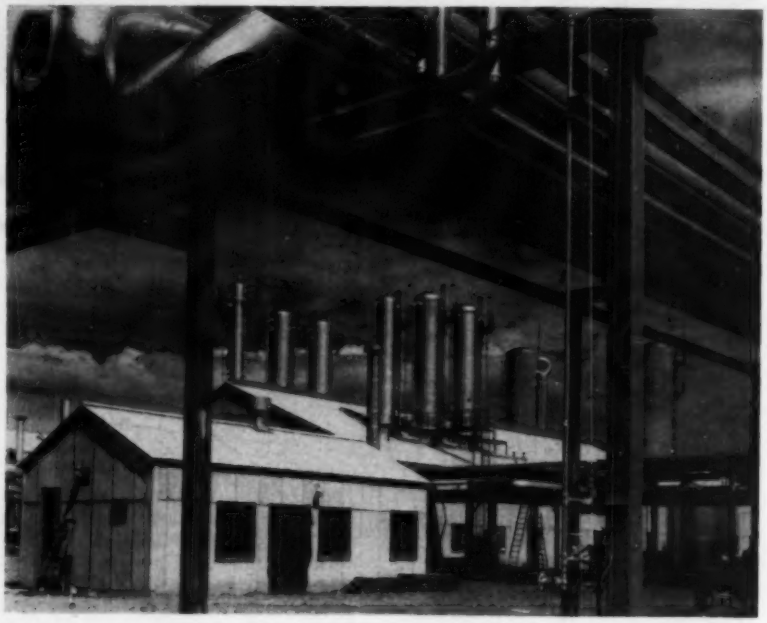
Auxiliary Equipment

Three 100,000 lb per hour boilers provide 300 psig, 550 F superheated steam for the Pincher Creek plant. Steam is also generated in the sulfur plant. Electricity is purchased, with power lines from two entirely separate sources, to reduce the risk of power failure. Circulating water for process cooling is provided by an induced draft cooling tower. Makeup water comes from a small lake about a mile from the plant, created by damming the Drywood River.

The process portion of the plant is largely controlled from a central control room. The plant can be completely shutdown in an emergency by an automatic system from any one of several strategically-located control points.

Storage facilities consist of two 750 long ton liquid sulfur tanks, two 12,000 bbl condensate spheroids, three 56,000 gal propane tanks, and three 56,000 gal butane tanks. A portion of the sulfur is solidified into large blocks for additional storage.

Process workers are dwarfed by process equipment at the Pincher Creek plant. Plant includes 17 buildings, most of which house process equipment to protect it and operators against the bitter cold of winter. Stage 2 engineering and construction was done by Ralph M. Parsons Company.



The amine treaters building at Pincher Creek. Plant is named for a nearby creek, where in about 1869 a gorup of prospectors lost a pair of pinchers. They were found several years later, and the stream given its present title.

Acknowledgment

Photographs and material used here were provided by British American Oil Company. The editor is grateful to the company for the opportunity of visiting the plant on October 15, 1958, when it was dedicated by E. C. Manning, Premier of Alberta.

—Whit Downer

DU PONT *Petroleum Chemicals* NEWS

Number 92 in a Series of Bulletins for the Petroleum Industry

NOVEMBER 1958

Progress report on "rumble" and "thud" studies

Five years ago, researchers in the Du Pont Petroleum Laboratory isolated a new phenomenon in the performance of high-compression ratio engines. They called it "rumble."

THE CHASSIS DYNAMOMETER setup at the Du Pont Petroleum Laboratory is helpful to Du Pont engineers in pinpointing the causes and effects of rumble and thud in high-compression ratio engines.

"Rumble," a low-pitched noise produced in engines of about 9.5:1 or higher compression ratio, is usually noticeable on hills or during accelerations above 40 or 50 miles per hour and when the throttle is wide, or nearly wide, open. Laboratory tests show that it is associated with a high rate of pressure rise within the cylinders of such engines, plus the presence of combustion chamber deposits.

Now—"Thud"

Another low-pitched noise has been noted in tests at the Du Pont Laboratory. It has been given the name "thud."

"Thud" takes place in the same types of high-compression ratio engines as "rumble," with one significant difference – it can occur in the absence of combustion chamber deposits.

FOA-2 makes costly tank cleaning unnecessary

Recently another case history of dollars saved through fuel oil improvement came to Du Pont: No. 6 residual fuel was being burned at a factory in upstate New York. This plant uses about 3 million gallons of fuel per year. It is first delivered to a 300,000-gallon storage tank and then transferred to a 17,000-gallon horizontal work tank.

Sludge build-up meant costly clean-outs

Sludge was playing havoc with the work tank, largely because the inlet and outlet connections were located at its head end, and sludge built up rapidly at the far end. When it reached a depth of several feet, it threatened to interfere with suction pipe operation. So every few months it was necessary to open the tank, and send a work crew inside to remove the accumulation manually. A "messy," time-consuming and costly job.

How FOA-2 solved the problem

Last February about 10-15 gallons of Du Pont Fuel Oil Additive No. 2 was poured into this tank, in the hope that it would stabilize the fuel and reduce sludging, thus extending the time between clean-outs. After the fuel in the tank had been consumed in the normal manner, it was quickly discovered that virtually no sludge remained. The additive had solubilized and dispersed the sludge, and stabilized the fuel. Therefore the plant promptly adopted a program of treating its fuel oil with FOA-2 to eliminate the costly clean-out operation.

If you or your customers are experiencing fuel oil sludging problems, let your Du Pont representative work out a solution for you.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DUPONT *Petroleum Chemicals* NEWS

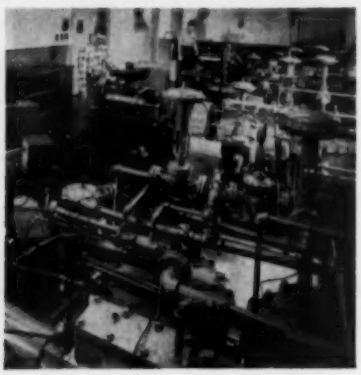
CONTINUED

"rumble and thud"

Investigations of both rumble and thud are going on today, in engines in the Du Pont Petroleum Laboratory. Gasoline technology stands to benefit importantly from these tests, as it has in the past from Du Pont investigations of "knock" and "wild ping."

Through these and other studies of combustion phenomena, Du Pont automotive engineers have gained extensive working knowledge of the behavior of hydrocarbons. This helps Du Pont work with refiners in blending gasoline stocks for optimum performance and lowest manufacturing costs.

▲ **LABORATORY,** as well as on-the-road and dynamometer engine tests, are employed by Du Pont scientists in their studies to uncover every detail related to rumble and thud. ▼



Details available to you

Numerous papers have been presented by Du Pont technologists on the subjects of rumble, thud, knock and ping. Your Du Pont Petroleum Chemicals representative will gladly get copies for you.

YOU OUGHT TO KNOW...

E. HEARN SIMPSON, Sales Manager of Du Pont's Petroleum Chemicals Division, joined the company in 1930 in the Fabrics and Finishes Department. Two years later he was transferred to the Organic Chemicals Department and for a number of years he was a salesman of products as diverse as industrial alcohol, anti-freeze and gasoline antioxidants.

Five years were devoted to sales of the latter, in both the Mid-Continent and Gulf Coast regions.

Hearn Simpson's career at Du Pont was interrupted for three years while he served as a naval officer on aircraft carriers in the Pacific theater of operations.

On his return to Du Pont in 1946, Mr. Simpson was made sales manager of alcohol and camphor. He was elevated to his present position in 1950.

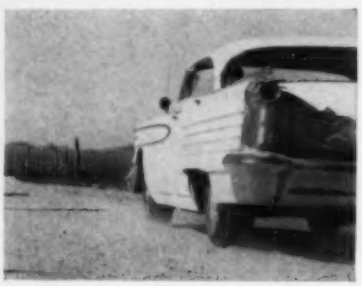
Mr. Simpson attended Colorado University and was graduated from the University of Denver with a Bachelor of Science degree.

Nylon cord tires a step toward highway safety

On today's turnpikes and thruways, four tire hazards are becoming increasingly serious. Tires with nylon cord are a long step toward eliminating them all.

Heat is the biggest threat. Sustained speeds of 60 or more miles per hour are not unusual on many of our superhighways. Nylon resists the effects of heat, reducing the chances of tire failure at these critical speeds.

The particular problem with heat is that it has a way of bringing out the worst in a tire, of finding and preying upon all the defects that may have come about through bruising, moisture and flex fatigue, the other three tire hazards.



Nylon corded tires have high resistance to heat.

Tough nylon safely withstands violent twists, bends and flexing without damage to the tire. And the chemical nature of nylon is such that moisture doesn't harm it.

As America's superhighway program moves forward, the demand for safe, reliable protection will result in the increased use of tires corded with nylon, another petrochemical product made possible by the cooperation of the petroleum and chemical industries.

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DU PONT
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Better Things for Better Living
... through Chemistry

Du Pont Tetraethyl Lead and other Petroleum Additives

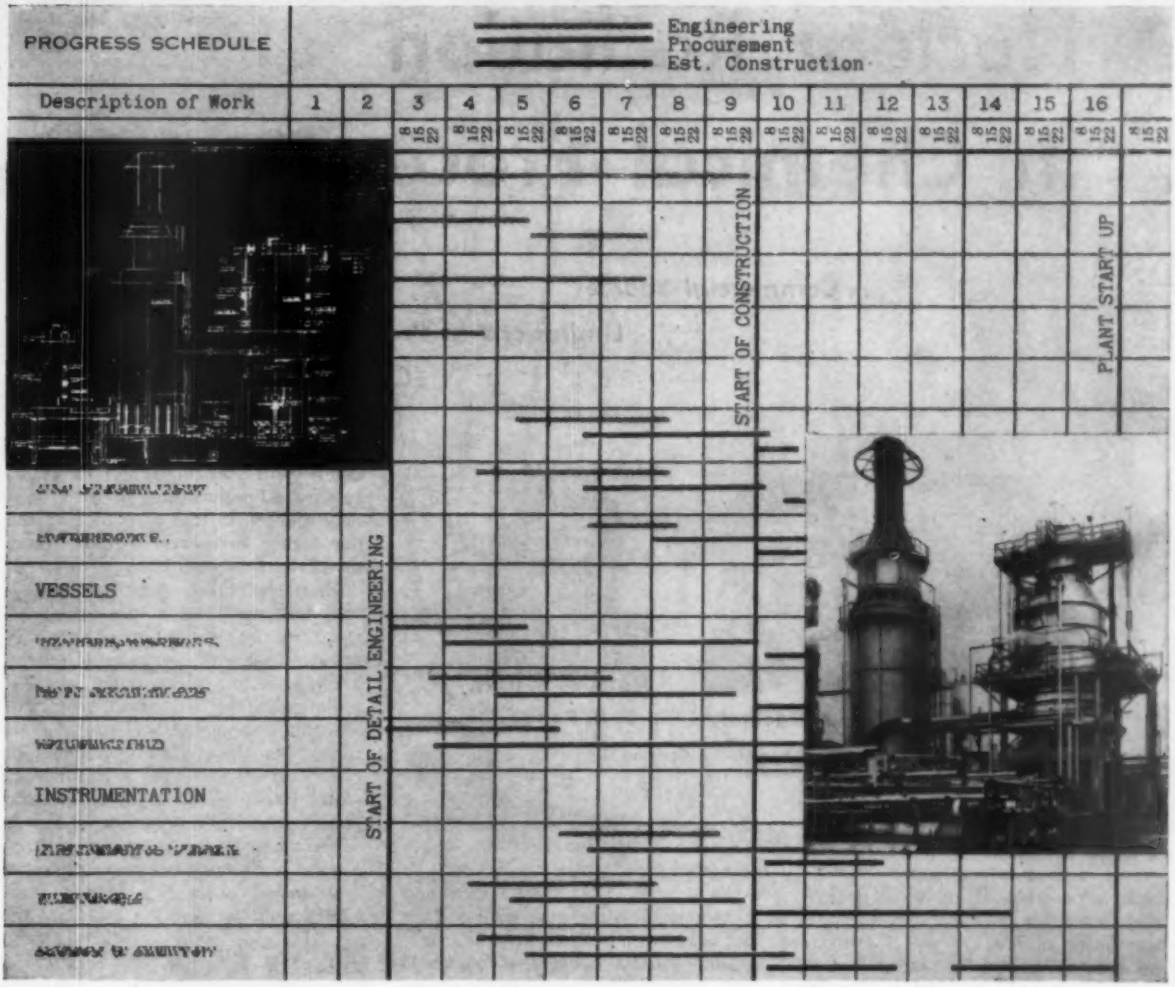
OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-8064

Printed in U. S. A.

Blaw-Knox builds vacuum unit for Ashland Oil.
Located at Canton, Ohio, this unit processes 15,000 barrels a day . . . proficiently reduces carbon content in cat cracker feedstocks . . . boosts overall refinery capacity.



From plans . . . to scheduling . . . to operation integrated construction pays off three times in two years

By placing this vacuum unit on stream on time, Blaw-Knox completes its third project for Ashland Oil and Refining Company. Within the past two years Blaw-Knox has also engineered and constructed two catalytic reforming and hydrogen desulfurization units for this expanding company. Each of these units was producing at capacity, on schedule, and within the budget requirements.

Blaw-Knox prizes its repeated association with many of the country's leading processing companies. For repeat business demonstrates as no other way can, the continuing endorsement of the technical background and engineering skill of this contract management organization.

Bulletin 2547 provides a graphic description of the erection, expansion, and modernization services for petroleum processing plants. For your copy, contact Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, N. J., Birmingham, Washington, D. C., and San Francisco.

for plants of distinction . . .

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. . . Commercial Sources
. . . Limitations in Process Systems
. . . Costs for Three Basic Schemes

F. T. Barr **H. J. Ogorzaly** **T. A. Reiter**

Esso Research and Engineering Company
Linden, New Jersey

WHILE generation of power has received the greatest emphasis in development of peaceful uses of atomic energy, there are other potential uses in which the power aspects are not of primary importance. This article is directed to one of these: The use of radiation for improving process reactions by acting as initiating agent. The subject is covered in three sections: (1) Commercial sources of radiation, (2) some of the limitations on its use in process systems, and (3) the general outlook on cost of radiation for processing operations.

Radiation Sources

Radiation in large quantities is now available as gamma rays from radioisotopes, electron beams from accelerators, and fast neutrons and gamma radiation combined from nuclear reactors. Type and intensity of radiation may have an important bearing on the chemical effects achieved, but this article is concerned primarily with the characteristics and costs of radiation in commercial quantities.

*Presented at Atoms for Peace Conference, Geneva, Switzerland, September, 1958.

Gamma radiation. An important characteristic of gamma radiation is its extreme penetrating power. Penetration of gamma radiation is far greater than that of electron beams and significantly greater than that of fast neutron beams in hydrogenous materials. In the choice of radioisotope for process irradiation, the exact energy of the gamma radiation seems to be of limited significance. Cost and convenience of the source are the primary considerations.

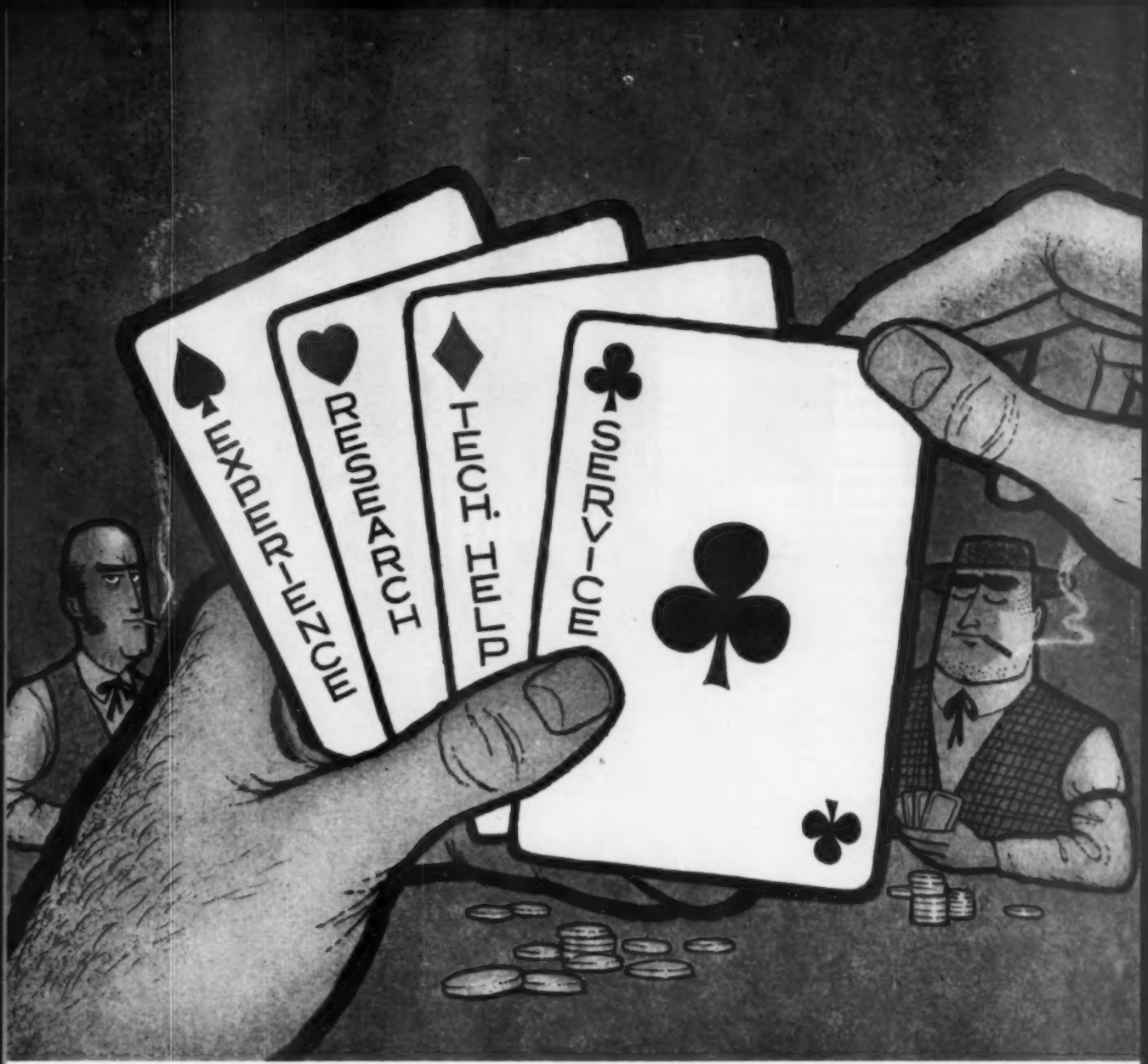
Although a number of different radioisotope sources have been suggested, most important at present is cobalt-60. Cobalt-60 has the advantage of a relatively long life so that radiation intensity can be maintained at a reasonably even level in a commercial installation, by making booster additions to the source annually. If the half life is too short, as appears to be the case with spent fuel elements, frequent change or boosting of the source would be required to maintain an even feed rate to the radiation process. A radioisotope with a longer half life than that of cobalt-60 might show an advantage. The only one that appears likely to be available in the necessary quantities is cesium-137, obtained by extraction from spent fuel elements. However, cesium-137 gamma energy per curie is only one-fourth that of cobalt-60 and the higher inventory required more than offsets its six-fold longer life.

Electron beams. Accelerators provide the most satisfactory source of electrons. Beta radiation is the truly nuclear source of electrons. However, because of the short range of their radiation and the consequent self-absorption problems, beta-emitting isotopes cannot be utilized for initiation of chemical reactions on a commercial scale. Exact energy of the electrons from the machine is of limited significance to the chemistry of the reaction, but the beam must be sufficiently energetic to pass through a window from the vacuum acceleration zone into the process zone with satisfactory efficiency.

From the standpoint of range in vapors, electron accelerators show a distinct advantage over either gamma-emitting isotopes or nuclear reactors. The 90 percent absorption distance for electrons in hydrocarbon vapor of 0.01 gm per cc density is only a little over one foot, compared to 200 ft for cobalt-60 gammas and 50 ft for pile neutrons.

There is a variety of machine accelerators offered commercially.[1] The resonant transformer and Van de Graaff are well developed, but their capacity limit is in the range of 25 to 50 kw per machine. The linear electron accelerator should be available in 60-kw capacity soon, and may ultimately go to 400-kw. The voltage multiplier . . . or d-c cascade . . . machines are potentially capable of reaching 100-kw capacity, or more, but are not as completely developed in large sizes.

An important problem in the use of accelerators for radiation processing is in design of the window between the



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vacuum zone and the process zone. Pressure in the process zone may be as high as 50 atmospheres. The window must be thin enough to allow entry of electron beam energy with only moderate loss, but strong enough to hold the system pressure.

Nuclear reactors can be used for process irradiation in a variety of ways. If pure gamma radiation is desired, an activatible material can be circulated through the core and thence to an irradiation zone, where decay gamma radiation is absorbed. This principle has been used in food irradiation reactor designs.[2] However, yield is low compared to that of radiation directly from the reactor core.

Another modification is the use of a pool type reactor with a process material blanket. The blanket would absorb the radiation ordinarily leaking from the core which, from data on the Oak Ridge bulk shielding reactor,[3] may be as much as two percent of reactor power. Here both neutrons and gamma radiation would be present. This technique might be useful in the smaller sizes, perhaps up to 100 kw of radiation demand.

The most direct use of a reactor for irradiation involves passing the process material through the core. Preliminary studies on reactors of this type were carried out with the assistance of Nuclear Development Corporation of America. If the chemical reaction did not produce any material that would deposit on the fuel elements, the feed stream could serve as both coolant and moderator. In our studies it appeared likely that the more general case would be that in which the chemical reaction did deposit coke or polymer on the fuel elements. The work was thus directed toward a reactor in which ordinary water is used as coolant, but in which the hydrocarbon content in the core is maximized to absorb as much gamma radiation and fast neutron energy as possible. The primary objective was to obtain an estimate of the feasibility and cost of reactor radiation based on presently available technology. Application to both liquid and vapor phase irradiation was studied.

Liquid phase reactor. A diagrammatic sketch of the liquid phase irradiation reactor studied is shown in Fig. 1. The core is similar to a shell and tube heat exchanger, with water and fuel plates on the tube side and the hydrocarbon surrounding the tubes as well as the whole core assembly. Cooling water is circulated at high enough pressure and temperature to allow production of 125 lb process steam; this requires the use of stainless steel in the core. The fuel tubes are covered with insulation so that conditions in the process zone can be set independently of coolant conditions. Some of the preliminary design figures are given below:

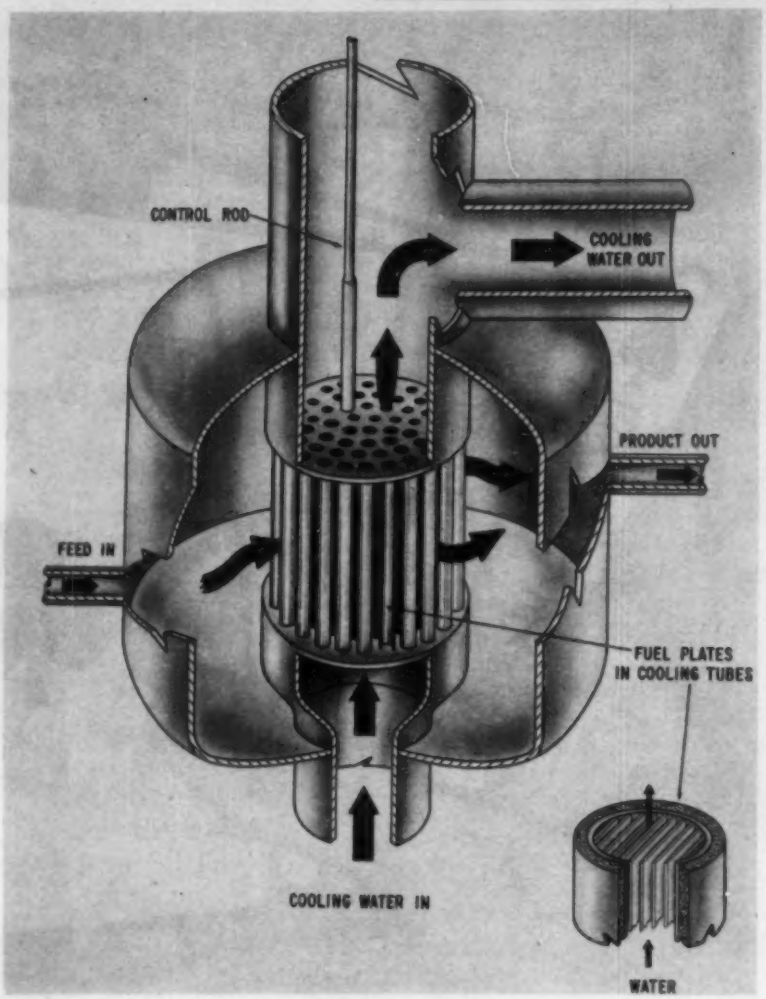


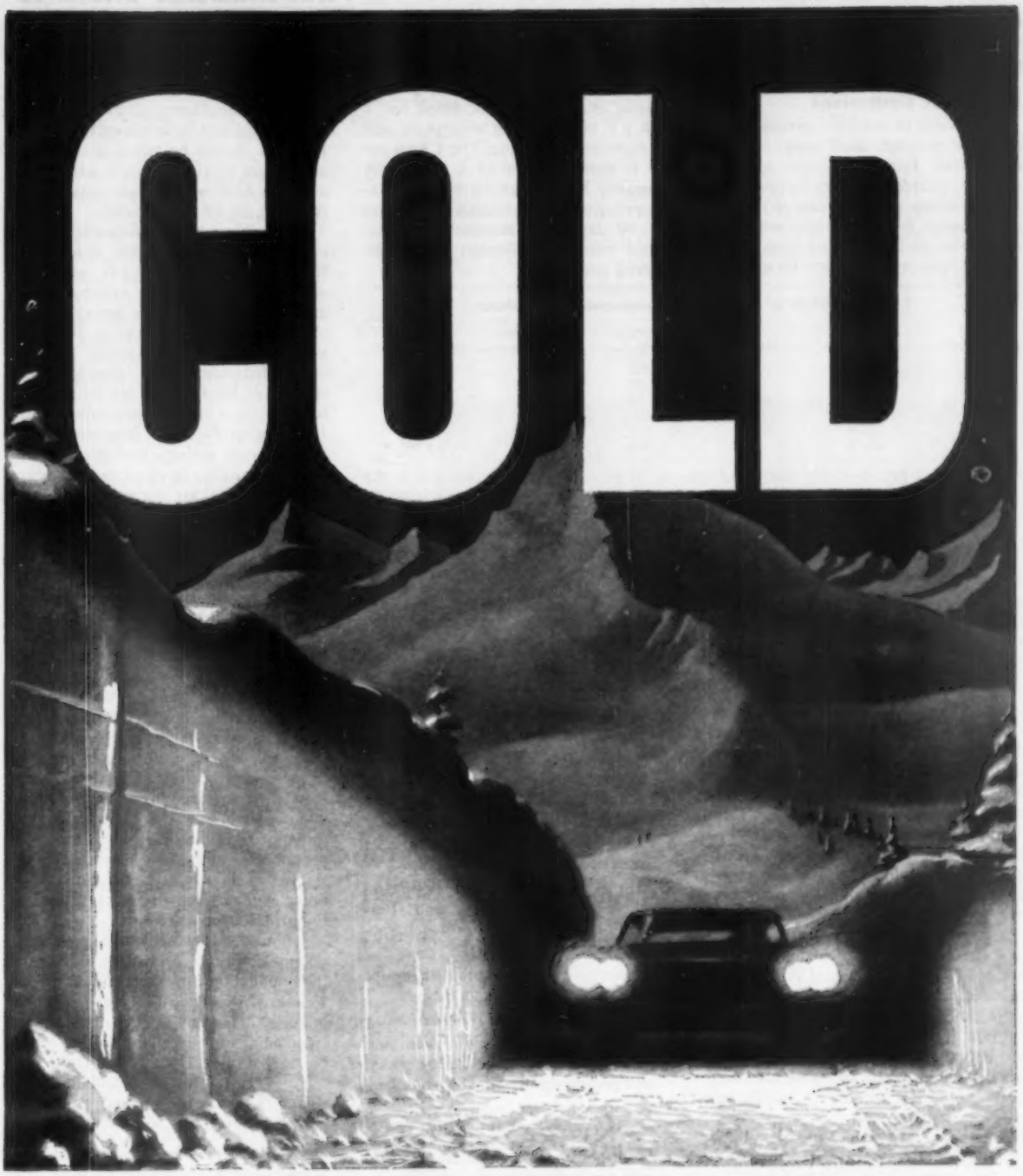
FIG. 1. Nuclear reactor for irradiation processing.

TABLE 1. Preliminary Reactor Design Data.

	Liquid phase	Vapor phase
Process material	Hydrocarbon	Hydrocarbon
Density, gm/cc	0.8	0.1
Diameter of Core, ft	3.2	6.7
Active Height, ft	3	6
Core loading, lb U-235	68	160
Power level, kw thermal	70,000	130,000
Radiation power, kw Absorbed in process material	3,000	3,000

These figures are approximate only, since a detailed nuclear design was not carried out. This reactor would yield about 4.2 percent of total power as radiation absorbed in the liquid hydrocarbon, or about one-third of the fast neutron and gamma radiation potentially available. If it were demonstrated that the feed could be used as coolant without causing excessive deposits on the fuel elements, some improvement might be made in this figure.

Vapor phase reactor. If the irradiation must be done in the vapor phase, a larger core and a lower radiation yield may be expected. Using the rather optimistic vapor density of 0.1 gm per cc, a vapor phase reactor, similar in configuration to the liquid phase unit shown in Fig. 1 was studied. As shown in Table 1, the core must be considerably larger to provide the same radiation power. In this case, heat was rejected to a cooling tower so that aluminum could be used as cladding and construction material, and minimize what might otherwise have been an excessive critical mass requirement. For the same reason, a graphite reflector was used. This reactor would yield about 2.3 percent of reactor power as



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radiation absorbed in the hydrocarbon vapors, because of the lower ratio of process material to coolant and metal.

Activation Limitations

A concern in radiation processing is that the product itself may become radioactive. For radioisotope and accelerator sources this is not a problem: With gammas and electrons of reasonable energy levels, product will normally have no residual radiation.

With reactors, activation by neutron absorption must be considered. Study of reactor irradiation of feeds with potentially activatible elements in them was therefore made. Table 2 gives a resume of activities calculated for 1 kwh per bbl radiation absorption and 30 days "cooling" time. The 1 kwh per bbl is representative of a reasonably economic level of irradiation in refining processes for petroleum fuels, and the 30 days is a reasonable storage period before distribution of a commercial product.

TABLE 2. Study of Activatable Compounds in Petroleum.

Element	Principal active product	Half-life	Activity[a] after 30 days	Permissible in air[b]	Allowable conc. in feed
P	P-32	14.3d	200	140	0.6%
S	P-32	14.3d	20	140	7.0%
C	S-35	87d	80	1000	12.0%
Cr	Cr-51	27.8d	500	8000	16.0%
Fe	Fe-59	47d	1.5	15	10.0%
Co	Co-60	5.3y	700	1200	1.7%

a. Microcuries per cc $\times 10^4$ calculated for one wt percent of natural element in 0.8 gm per cc process material. This has associated with it, in a hydrogen-moderated reactor, about 3×10^{14} "fast" and roughly 2×10^{14} thermal neutron dosage per cm^2.
b. Permissible levels of radiation in unrestricted areas, microcuries per cc $\times 10^{10}$. U.S. Atomic Energy Commission, January 1957.

Amounts of activatible materials allowable are also shown. This assumes that the permissible levels of radiation in unrestricted areas allowed by the U. S. Atomic Energy Commission for its licensees will be an acceptable criterion.[4] It should be noted that public acceptance of such limits is uncertain, and that AEC is at present considering reducing the allowable levels.

Allowable concentrations were based on maximum permissible concentrations in air. Data on CO_2 and CO concentrations in air arising from automobile exhausts in heavy traffic areas[5] show that at least a 10^6 volume dilution factor (actual volume of diluted combustion products per volume of liquid fuel) can be applied for burning a liquid hydrocarbon. The 10^6 dilution factor is consistent with direct liquid activity limitations. The AEC permissible levels of radioactivity per cc of drinking water are roughly 10^4 times those per cc of air. An additional 10^2 factor would be needed to bring the direct liquid limitations to the same levels as calculated from air limits using a combustion dilution factor. This additional factor seems reasonable to allow for the less intimate body contact expected with almost any irradiated product compared to drinking water. Problems with relatively short-lived activities, e.g., P-32, can be alleviated by longer storage periods.

Calculations for carbon, hydrogen, oxygen, and nitrogen indicated that they will not exceed the activation limit at anywhere near the 1 kwh per bbl radiation dose. Sulfur, chlorine, and phosphorus limitations might become significant in some applications. The other elements shown are examples of impurities from corrosion.

It appears that activation problems do not constitute a positive barrier to the application of reactors as radiation sources for processing of organic materials. However, they could be significant, and each application must be studied on its own merits. There are many uncertainties in calculations of this sort, and experimental check of activities developed will usually be required.

Radiation Economics

Estimated unit costs of the types of radiation described above, and indication of their buildup are given in Table 3. The costs are those expected to be possible within the next five years, using known technology.

Construction and operating costs are based on U. S. industrial experience. Cobalt-60 is charged at 50 cents per curie. The gamma and electron beam absorption efficiencies were taken as 90 percent, and their service factors

Radiation Processing —What are its Potential Uses?

This article by scientists with Esso Research and Engineering Company discusses commercial sources and costs for radiation processing. Why the interest in radiation processing? Certainly not because of the novelty . . . commercial organizations, even commercial researchers, are far too practical to pursue something for reasons of novelty alone.

Many applications have been suggested for radiation processing, some of which will prove practical in the foreseeable future. The list of suggested applications following, compiled by the editors from the literature, is by no means exhaustive. But, it does illustrate clearly the powerful tool that radiation processing may become . . . within just a few years.

- Promotion of cracking at lower temperatures and pressures than possible in the absence of radiation.
- Chemical stabilization of distillates . . . destruction of gum and precipitation-forming substances by exposure to radiation in the presence of oxygen, followed by redistillation.
- "Sweetening," the destruction of mercaptans in naphthas and various distillates.
- Increasing speed of combustion in rocket and jet engines.
- Activation of catalysts, e.g., for hydrocarbon synthesis.
- Preparation of titanium and similar catalysts for ethylene polymerization.
- Preparation of stable coal-in-oil dispersions for use as diesel fuel.
- Production of pour point depressants and viscosity index improvers.
- Manufacture of polymers from ethylene, propylene, etc., and after-treating products to improve characteristics.
- Production of polysulfone resins from sulfur dioxide and olefins.
- Production of "graft" polymers.
- Cross-linking of paraffin wax and polyethylene to raise melting point and reduce solubility.
- Vulcanization of rubber, including silicone rubber.
- Chlorination of aromatics . . . especially for insecticide manufacture . . . and of polyolefins.
- Conversion of hydrocarbons to sulfonates: $RH + SO_2 + \frac{1}{2}O_2 \rightarrow RSO_2H$
- Promotion of low-temperature reaction between hydrocarbons and oxygen to yield valuable oxygenated compounds.
- Sterilization of surgical goods, preservation of foods.
- Nitrogen fixation: $N_2 + O_2 \rightarrow 2NO$

also as 90 percent. For the reactors, 80 percent service factors were used.

Effect of capacity on costs. The costs in Table 3 are for differing capacities, each characteristic of the type of source. Amount of radiation needed in each unit may affect unit cost more than type of source. To evaluate this, the cost data from Table 3 were adjusted to include fixed charges and plotted in Fig. 2. For this purpose, depreciation and return on investment of 16 percent after 55 percent U. S. income tax were included as representing a reasonable evaluation of the business risk involved. Some roughly estimated figures for smaller units judged to be available at present, and some extrapolations to even larger units projected for the future were also used. Without taking into account the possible differences in ability of the various types of radiation to promote chemical reactions, it is seen that there is a decided capacity effect for accelerators and nuclear reactors.

Two cost levels are shown in Fig. 2 for cobalt-60. At present, the minimum price is $2 per curie, but this may decrease to the 50 cents per curie in the reasonably near future.[6] In the case of electron accelerators, larger capacity machines are expected to be obtained by presently programmed developments. If a process needs still larger amounts of radiation at any given stage of accelerator development, multiple units would have to be installed, and the unit radiation cost would not decrease appreciably.

Fig. 2 indicates that cobalt-60 is most likely to be economic in small sizes, accelerators in the intermediate range, and reactors in capacities greater than the order of 200 to 1000 kw of radiation.

Long range prospects. These figures are based on projections into the near future. Long range, there are at least two avenues that could lead to lower radiation cost and improve the prospects for radiation processing. One of these is modifying a power reactor to obtain by-product radiation. This could be attractive to a utility at a net realization relatively low compared to the costs above. Development of this source of radiation, however, depends on solution of the problems in cooperative use of a large scale installation, and establishment of good prospects for substantial demand for such radiation.

The other avenue is the possible use of fission recoil radiation. This would make available practically all the energy of fission for process initiation, compared to about 13 percent available as gamma radiation and fast neutrons. The concept would require use of the fuel in solution or in particles or fibers a few microns in diameter to allow absorption of a reasonably high proportion of the fission recoil energy in the process material as effective radiation.[7] Because of the short range of fission fragments this concept would appear to have promise for vapor phase process irradiation. However, serious problems of radioactive contamination of the product must be solved.

TABLE 3. Estimated Costs for Radiation Processing.

Source:	Co-60	Linear accelerator	Nuclear reactor	
Capacity, kw abs'd	10	60	3000	
Phase	Liquid	Liq. or Vap.	Liquid	Vapor
Investments, per kw				
Source	$40,500	$ 9,200	—	—
Other	1,500	2,700	—	—
Total	$42,000	$11,900	$3,000	$4,900
Costs, per kwh radiation				
Source replenishment	55¢	—	—	—
Operations*	24¢	44¢	6¢	13¢
Steam credit	—	—	—4¢	—
Totals*	79¢	44¢	2¢	13¢

*Excluding charges for depreciation, taxes, and return on investment.

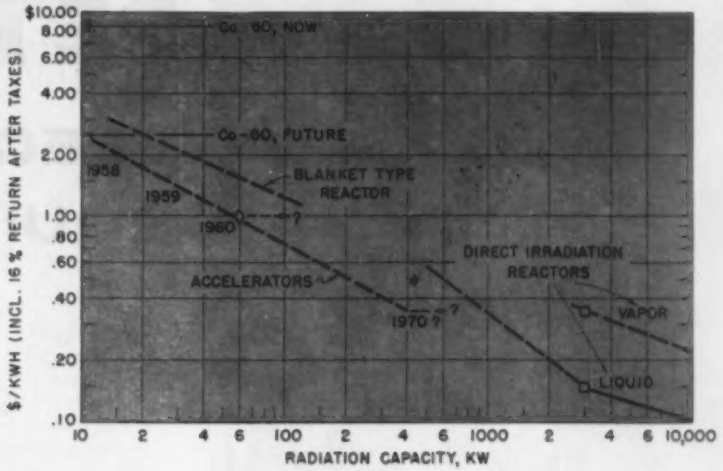

FIG. 2. Rough estimates of radiation costs.

Summary

1. Radioisotopes, electron accelerators, and nuclear reactors can all be used as commercial sources of process radiation, on the basis of known technology.
2. While small amounts of radioactivity might be present in products from nuclear reactor radiation, prospects for satisfactorily limiting this are promising. This would be done by control of feed purity, amount of radiation, and "cooling" in storage.
3. In the reasonably near future, cobalt-60 radiation could be available for process radiation at $2.50 per kwh, including return on investment; electron beam energy at $1 per kwh; and reactor irradiation at 15-35 cents per kwh. Size of the source affects cost more than type.

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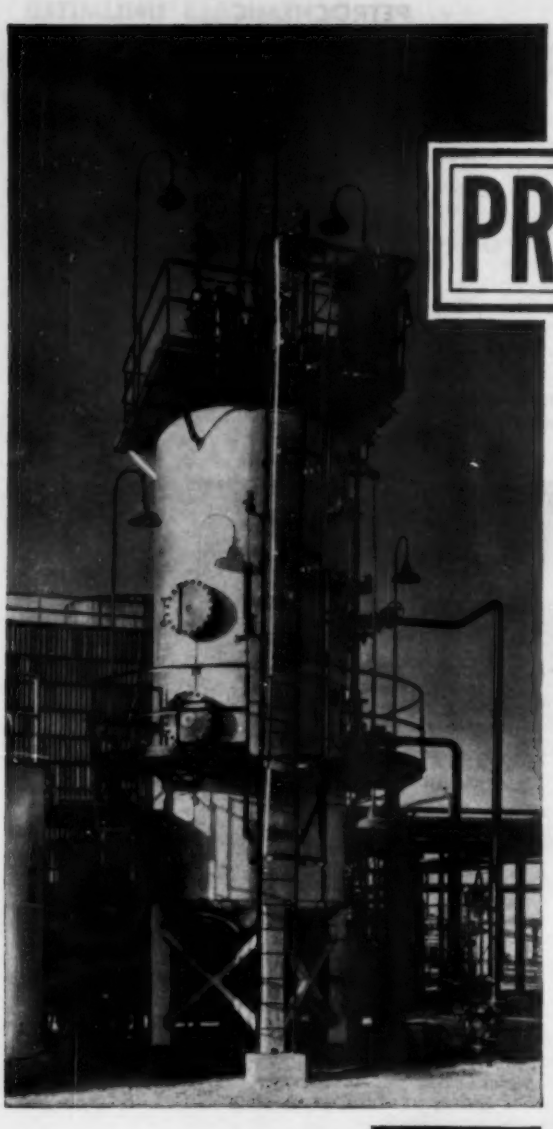

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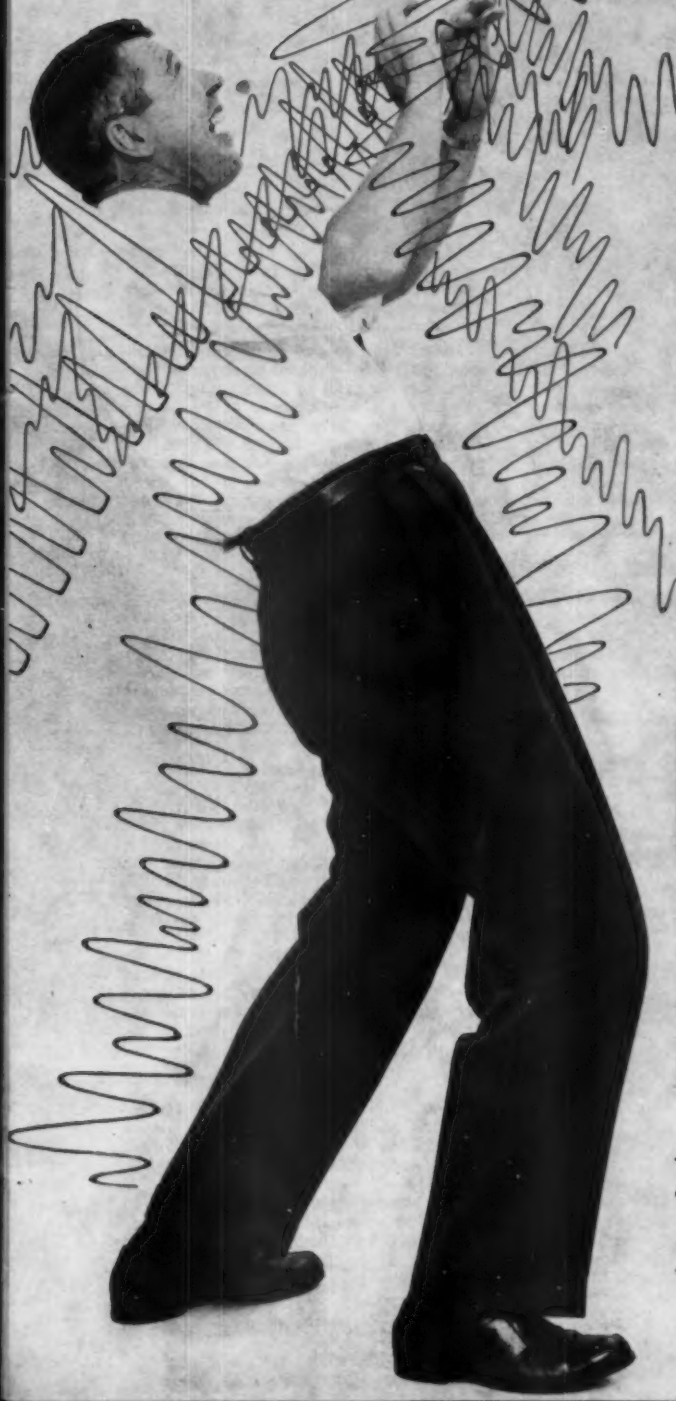

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MEN in INDUSTRY

▸ **Dr. Charles W. Seelbach** has been promoted in the chemicals research division of Esso Research and Engineering Company as head of the chemicals section. **Charles A. Cohen,** with Esso for 28 years, has been named a research associate. **Edward J. Brenner,** former contract attorney in the firm's process licensing unit, has been appointed acting assistant director in technical information division. **Lewis A. Winkler,** section head in charge of additives and chemicals activities, has been named head of chemicals liaison unit in London. **Leo V. Mullen Jr.,** formerly group head in additives section, is now a section head in charge of additives activities. **Oliver J. Kangas** has been named operations manager, a newly created position at assistant director level, in charge of operating activities in products research division. **Nathan V. Hendricks** has been appointed senior engineering associate by the executive committee. He is presently on company assignment in Europe. **Robert R. Risher Jr.,** former group head in products research division, has been appointed head of a newly-created business and mechanical section.

▸ **Joseph R. Mares** has resigned from the board of directors of Petro-Tex Chemical Corporation to undertake consulting work of a classified nature for the Government. Mares had been managing director of Petro-Tex since its formation in 1955. **J. J. King,** senior vice president of Tennessee Gas Transmission Company and a director of Petro-Tex, will assume Mares' duties.

▸ **Robert D. Bent** has been appointed manager of The Atlantic Refining Company's new technical service department. He was formerly assistant director of the development division of Atlantic's research department.

▸ **W. D. Seyfried** has been promoted to head Humble Oil & Refining Company's research and development division at Baytown, Texas. Seyfried has been with Humble 20 years and assistant head of

W. D. Seyfried

Dr. A. A. Draeger

R&D since 1948. He replaces **Dr. A. A. Draeger,** who has joined Humble's marketing department in Houston as manager of general office sales.

E. W. Lewis, J. R. Miller, J. P. Peet and **D. H. Wilson** have been transferred from R&D at Baytown to marketing department in Houston.

▸ **J. F. McCanne,** former chief process engineer, has been promoted to senior technologist in Magnolia Petroleum Company's technical department. **A. B. Hiser,** formerly assistant chief process engineer, succeeds McCanne.

▸ **Dr. Wayne C. Edmister,** noted authority on fractionation and absorption, has joined the faculty at Oklahoma State University. He is a professor of chemical engineering, in the department headed by **Dr. R. N. Maddox.** Dr. Edmister, author of *The Refining Engineer's* reprint "Hydrocarbon Fractionation and Absorption Design," was formerly with California Research Corporation.

▸ **Paul Bilger** has been named superintendent of the Lake Superior Refining Company. His former position was chief engineer. **Joseph I. Lanctot** has been advanced from process foreman to assistant superintendent in charge of operations. **Leo M. Zalaznik** has been promoted to assistant superintendent in charge of maintenance. Zalaznik was formerly a maintenance foreman.

▸ **Thomas E. Fitzgerald** and **Glenn E. Wynn** have been advanced to newly created senior vice president posts of D-X Sunray Oil Company. Wynn was recently named president of Suntide Refining Company and Fitzgerald was named executive vice president of Suntide.

▸ Five specialists from Standard of Indiana's Whiting research laboratories have been appointed to act as consultants to each of the company's refineries to better coordinate applied manufacturing research and operating experience. The specialists and their fields are: **C. O. McKinney,** catalytic cracking; **W. R. Hertwig,** catalytic reforming; **J. H. Lovett,** alkylation and polymerization; **Moses Gordon,** final treatment of gasoline and other fuels, and **R. J. Austin,** control and recovery of wastes. **C. R Harte,** coordinator of technical service will direct the overall program.

▸ **M. F. Granville** has been named general manager of The Texas Company's petrochemical department. Prior to this appointment, he was superintendent of the chemicals division.

▸ **Dallas Jennings,** of Esso Standard Oil Company, who helped pioneer many advances in the fields of greases, lubricating oils and the development of petroleum products for the aviation industry, has retired.

William F. Thiede, an assistant general manager of manufacturing for Esso Standard and one of the company's longest-service employees, has also retired.

Refining Books to Read

Vinyl Resins, *by W. Mayo Smith, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 282. Price $5.75.*

This book thoroughly surveys the applications of vinyl resins against background information on their types, properties, chemistry, manufacture and fabrication. Most of the recent advances in the vinyl field are covered.

▸ **Cellulosics,** *by Walter D. Paist, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 270. Price $5.75.*

A clear, concise survey of the applications of cellulosics based on their properties is presented in this new book. Introductory chapters on the chemistry, properties and fabrication methods of cellulosics precede extensive examples of their applications. Latter chapters include fibers, films, molding powders, protective coatings, adhesives, thickening agents and a wide variety of other uses.

Bacterial Activity in JP-4 Fuel, *by S. Bakanauskas, U. S. Air Force, Wright Air Development Center. Order PB 131813 from Office of Technical Services, U. S. Department of Commerce, Washington, 25, D. C. Pages 20. Price 75 cents.*

Research at Wright Air Development Center disclosed that certain types of bacteria thrive in kerosine-type jet aircraft fuel and form sludge which could easily affect filter systems. The bacteria emulsify the fuel to form gummy residues, then themselves form precipitates. Details of evaluations of the corrosion inhibitors and gum inhibitors are presented in this report, along with descriptions of methods and results.

API Specifications for Centrifugal Compressors for General Refining Services, Tentative Standard 617, *published by American Petroleum Institute, Publications Department, 50 West 50th Street, New York 20, New York. Pages 29. Price $1.50.* **Data Sheet for Centrifugal Compressors** *is available separately. Pages 6. Price 15 cents.*

Specification covers the minimum requirements for basic design, materials, inspection, and tests for centrifugal compressors used in refining services handling air or gas, but excludes machines developing less than 5 psi. Included are motor, steam, or gas turbine, and engine-driven compressors, related lube-oil and shaft-sealing systems, controls, auxiliary equipment, and gear units.

Petroleum — Prehistoric to Petrochemicals, *by G. A. Purdy, Consulting Engineer, Research Chemist and Technical Information Specialist with Imperial Oil, Ltd., published by McGraw-Hill, 327 West 41st Street, New York 26, New York. Pages 500. Price $15.*

This book represents a new concept in an authoritative reference book. Combining basic ideas with the latest technical advances, the book traces the development of the petroleum and petrochemical industries from geological and archaeological beginnings to present-day products. Excellent illustrations and flowsheets, most major processes explained in some detail. Recommended for nontechnical readers, students, new engineers, as well as petroleum experts.

▸ **A Guide To Plastics,** *Second Edition, by C. A. Redfarn, published by Philosophical Library, 15 East 40th Street, New York 16, New York. Pages 150. Price $7.50.*

This second edition incorporates the many and important developments that have taken place since 1951. It has been almost entirely rewritten and enlarged, and new charts and diagrams prepared. A comprehensive picture of the whole field of plastics, and exactly what plastics are and how plastic products are made is given. Basic and intermediate raw materials employed are clearly described in detail. Seventeen colored charts show all stages of manufacture in each of the main categories of plastics.

Knock Characteristics of Pure Hydrocarbons, *published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania. Pages 100. Price $6.*

The data presented in this publication represents almost $1 million worth of research effort by the American Petroleum Institute Research Project 45 carried out at the Ohio State University.

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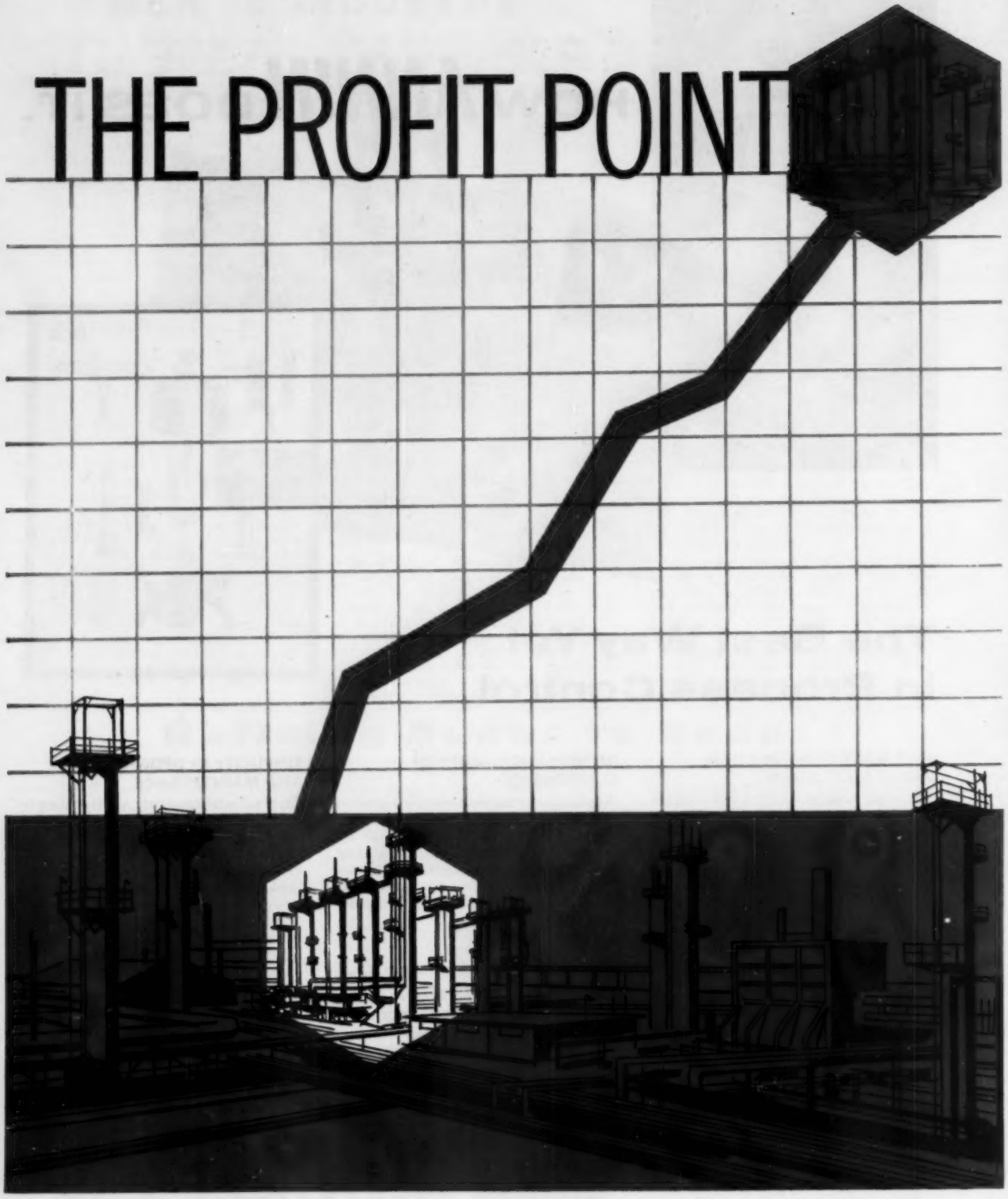

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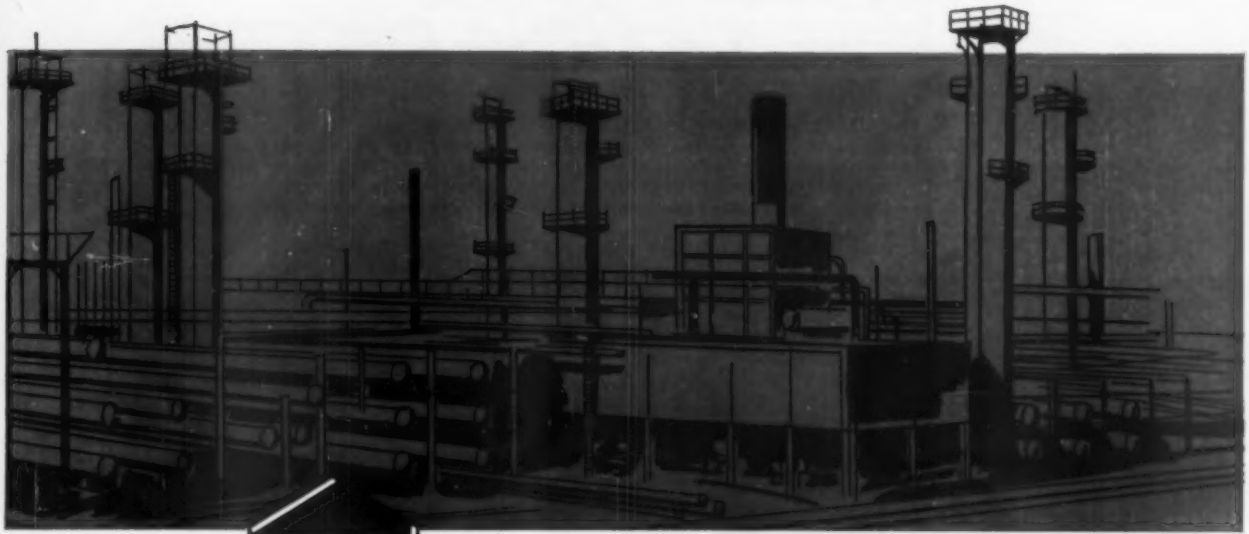

Technology UOP

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Does the effectiveness of an antioxidant eventually decrease?

Du Pont's Bill Robinson answers an oil man's questions about antioxidants

Q. Does the effectiveness of an antioxidant eventually decrease?

A. Over a period of time the concentration of antioxidant gradually decreases as it does its job of stabilizing the gasoline. Eventually the antioxidant will be completely used up if the gasoline is stored for long periods.

Q. Then how can the antioxidant be of value?

A. Antioxidants function in fresh gasolines by terminating chain-forming initiators that lead to gum formation. When the antioxidant is completely consumed, gum formation can continue, but normally gasoline is used long before the antioxidant is depleted.

Q. How much antioxidant is required to do a good job?

A. This depends upon the gasoline type and the length and severity of storage to which it will be subjected. Antioxidants are effective in very small quantities and usually 4 to 8 pounds per 1000 barrels are adequate. Economy is the reason antioxidants are preferred for eliminating potential gum problems.

Q. How can a refiner tell how much antioxidant he requires?

A. The best procedure is to evaluate the gasoline in 110°F. storage and to establish a correlation between the 110°F. storage and an accelerated test. Accelerated tests by themselves are frequently unreliable, but a useful rule of thumb used by many of the refineries is that the gasoline should have at least a 150-minute increase in induction period due to the addition of an inhibitor.

Q. Can antioxidants overcome the catalytic effect of copper?

A. Not completely, although for practical purposes high dosages of antioxidant will minimize those detrimental effects. This is uneconomical, and the use of Du Pont Metal Deactivator is the preferred treatment to overcome copper contamination of fuels.

Q. Are antioxidants preferred over chemical processes for producing stable gasolines?

A. For most gasolines the answer is yes.

Q. Why?

A. It comes right down to dollars and cents. Antioxidants are less expensive because no expensive equipment or product loss is involved. Antioxidants also provide an "insurance value" to products after they leave the refinery. The antioxidant continues to work even after the gasoline passes beyond the refiner's control.

Q. Can chemical treating and antioxidants be combined?

A. Antioxidants are frequently used to supplement caustic washing and also have been used after more drastic chemical treating procedures.

Q. What are the main classes of antioxidants used in motor gasoline?

WILLIAM T. ROBINSON is head of the Du Pont Petroleum Laboratory's Product Application and Service Division. In this capacity, he supervises technical work on gasoline and fuel oil additives. "Bill" and his associates work closely with refiners on problems concerning the effective use of petroleum additives.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

A. There are three that are widely used. These are the phenylenediamine type, such as Du Pont Antioxidant 22; the aminophenol type, such as Antioxidant 5; and the alkylated phenols such as Antioxidant 29. All three classes are potent antioxidants.

Q. Why does Du Pont market three different antioxidants?

A. This is in line with the Du Pont policy of supplying a complete line of additives for petroleum products. All of these antioxidants are excellent and any one may show up to advantage in a particular stock.

Q. What are the advantages, for example, of Antioxidant 22?

A. Antioxidant 22 is approved for use in aviation gasolines and may be used before a caustic wash and over strongly alkaline tank bottoms. Since it is 100% active ingredient it requires less handling and may be used for antioxidant sweetening of low mercaptan stocks.

Q. Which stocks are best suited for Antioxidant 22 sweetening?

A. It is generally considered that full boiling range, catalytically cracked gasolines, and blends of catalytically cracked and straight-run gasolines, are best suited for antioxidant sweetening. Many other stocks have been successfully antioxidant sweetened, but because of the moderate mercaptan sulfur concentrations, the presence of olefins, etc., Antioxidant 22 sweetening is almost universally applicable to cat-cracked gasolines.

Q. If Antioxidant 22 is used for sweetening, are any of its antioxidant benefits lost?

A. Studies have indicated that there is a slight loss of antioxidant, but it is quite small if the system is controlled carefully.

Q. What is the maximum mercaptan sulfur content that can be sweetened with Du Pont Antioxidant 22?

A. This varies according to the stock. There have been several cases of high mercaptan sulfur content stocks being successfully sweetened. However, as a rule of thumb, Antioxidant 22 sweetening should not be applied to stocks having more than 0.01 weight per cent mercaptan sulfur unless the sweetening system is carefully controlled.

Q. In the sweetening process, how early should Antioxidant 22 be added?

A. Generally, Antioxidant 22 should be added as soon as possible after H_2S and thiophenols have been removed by caustic washing. This early addition permits effective mixing and allows more time for the sweetening reaction.

Q. Do antioxidants increase intake system deposits?

A. No, in practical use concentration antioxidants have a beneficial rather than a detrimental effect because they prevent formation of gum which could contribute to intake system deposits.

FOR FURTHER INFORMATION on antioxidants, call in your Du Pont representative or write Petroleum Chemicals Division, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Del.

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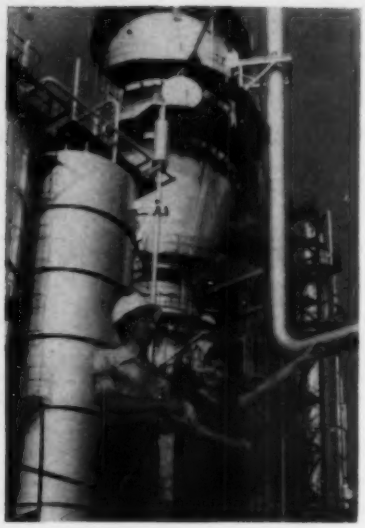
♦ B-A's new refinery processes 20,000 BPD of Western Canadian crude. In this view, the alkylation unit is in the foreground, while behind it are the catalytic cracker and gas recovery facilities, desulfurization units, and crude distillation unit, respectively.



Refinery manager C. W. Coote answers questions for pretty visitor June Watt. The 9000 BPD Orthoflow FCC is in the background.

British American

ONSTREAM AT

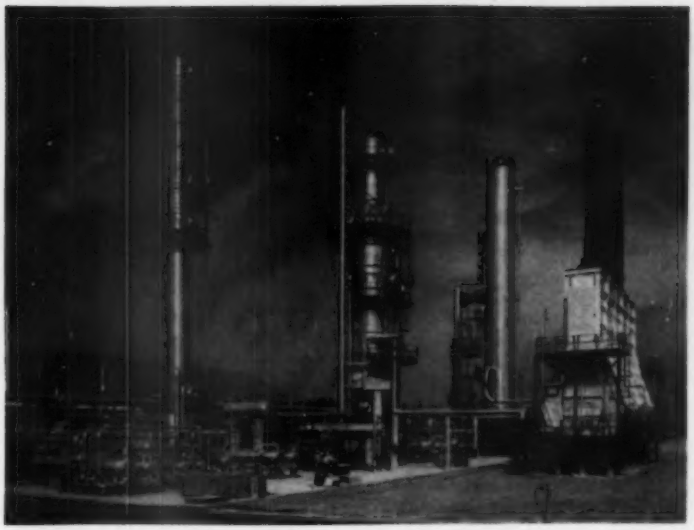
THE SILVER TOWERS and vessels of the new refinery, nestled in a majestic scene of blue water, tree-covered hills, and snowy mountains seem symbolic of Western Canada's dynamic growth. We are viewing British American Oil Company's newest refinery, at Port Moody, British Columbia. The refinery site is carved out of virgin timberland, where survey parties in 1946 were actually chased by bears!

This 20,000 BPSD refinery has been in operation just a short while, and will be officially dedicated later in the day . . . October 17 . . . by British Columbia's premier, W.A.C. Bennett. It is an eventful time for B-A's people . . . on October 15, the company dedicated its new Pincher Creek, Alberta, gas processing plant. Official opening of the $25.5 million refinery means that the company has inaugurated $50 million worth of new plants in just 48 hours!

B-A is properly proud of Port Moody, its sixth refinery. It is electronically instrumented throughout, and includes provision for possible doubling of the existing units. The functional in-line layout of process units and tankage simplifies piping and eases maintenance. The alkylation unit is the first for both the province and the company, with the middle distillate desulfurizer having the same distinctions. The CO boiler is the first in British Columbia's five refineries, and Port Moody is the first Canadian refinery to use completely automatic tank gaging throughout. The all-electronic instrumentation system on the process units is the first complete installation in Canada, too.

It was intended to build closer to the water and use salt water for cooling, but this proved impractical when surveys showed a geological fault in the land. As a result, the refinery is built higher up on a hillside, its various buildings terraced at different levels. Water is drawn from City of Port Moody mains.

The processing plants include combination crude topping and vacuum distillation, catalytic cracking, naphtha desulfurization and catalytic reforming, middle distillate desulfurization and alkylation units. Engineering-construction contractor for these units was Canadian Kellogg Company. Almost all of the equipment is of Canadian origin, with some $3 million worth of equipment and supplies purchased in the Vancouver area. Wages paid during building topped $5 million.



The 20,000 BPD crude topping and vacuum distillation unit handles 28 to 41 API crude, fortified with 600 BPD of isobutane. Tower in the foreground debutanizes desulfurized light straight run gasoline.

A section of the alkylation unit, first in British Columbia. It will produce 1050 BPD of motor gasoline blending component.

Model of the Port Moody refinery is studied by B-A engineers Barry Hercus, on the left, and Bill Rea, focusing their attention on the catalytic cracker. This model had a key role in refinery design, construction, and personnel training.

PORT MOODY

Whit Downer, *Editor*

Crude Topping and Vacuum Distillation Unit

Design capacity of the crude unit is 20,000 BPSD of Western Canadian crudes, ranging from 28 to 41 API and fortified with 600 BPSD of isobutane. Products inclu[illegible]as, 380F E.P. gasoline, kerosine or stove oil, diesel oil, atmospheric and vacuum gas oils, and residuals.

A straight run debutanizer on the crude unit plot processes light gasoline from the desulfurizing section of the reforming and naphtha desulfurizing unit. By desulfurizing combined S.R. gasoline and naphtha overhead fraction, need for treating S.R. gasoline in another unit is avoided. This also allows future production of desulfurized jet fuel. Alternately, the S.R. debutanizer can stabilize crude tower overhead when either the reforming and desulfurizing unit or the alkylation unit is down.

Cleanliness and end point control is provided for crude tower sidestreams. The vacuum tower incorporates positive tray wash and bottoms quench. Design is such that this combination topping-vacuum unit will operate independently when adjacent units are shut down.

This is an over-all view of the sulfuric acid alkylation unit. Model B cascade-type reactors are used.

The 13 crude oil and product tanks have total capacity for 617,500 bbl. All are equipped with floating roofs and electronic tank gages that read-out at a central location. Continuous, automatic facilities are used for gasoline blending.

Orthoflow FCCU and Gas Recovery

The fluid catalytic cracker, with regenerator mounted over the reactor, is considered a 9000 BPSD unit. Along with gas recovery equipment, it is actually designed for four basic operations, all based on synthetic catalyst:

Case I: Processes 9000 BPSD of gas oil from high-sulfur crude. Conversion is 62.5 percent at 1.50 TPR and 900 F reactor temperature.

Case II: Feed is 7000 BPSD of gas oil blend derived from Britamoil crude tankered in, plus extraneous streams from the naphthas and cycle oil desulfurizers, future visbreaker, and catalytic reformer. Included in the latter is H_2-rich gas. Conversion is 55 percent at 1.10 TPR and 900 F reactor temperature.

Case III: Based on 4000 BPSD of Britamoil crude-derived gas oil, conversion is 71 percent at 1.60 TPR and 900 F.

Case IV: Gas oil blend is charged at 7000 BPSD. Conversion is about 60 percent at 2.0 TPR and 875 F, and yields minimum amounts of heavy cycle oil product.

FCCU fractionator products include overhead gas and catalytic gasoline, light and heavy cycle oil. Heavy cycle oil is removed by a total drawoff pan above the reactor product scrubbing section at the base of the column.

Provision has been made for a future feed preheat furnace at the FCCU, which is a heat-balanced unit.

The conventional gas compression-recovery plant provides fuel gas, debutanizer overhead sent to the alkylation unit, and stabilized catalytic gasoline. Towers include an absorber-stripper and a debutanizer.

Naphtha Desulfurization Unit

The naphtha desulfurization unit uses cobalt molybdate catalyst for the HDS reaction. It's designed to process the 380F E.P. and lighter fraction from the crude unit, to supply reformer feed, a light naphtha feed to the S.R. debutanizer at the crude unit, and a jet fuel product stream.

Vapor from the H.P. separator is sent to fuel gas and prefractionator overhead vapor to the FCCU recovery system. Facilities are provided for processing a maximum of 4000 BPSD of stabilized naphtha feed from storage. Provisions have been made for later addition of a stripper to make feed for an isomerization unit, and a rerun tower for production of turpolene from part of the reformer feed.

Catalytic Reforming Unit

The 4000 BPSD reformer can operate down to 60 percent of design capacity, while the second reactor can operate at either 400 or 500 psig inlet pressure. Products include 95 F-1 reformate, which can either be debutanized or stabilized; a C_3/C_4 fraction to the alkylation unit; and vapor sent to the FCCU recovery system.

H_2-rich gas produced is used in the HDS units, with excess sent to the gas recovery section at the FCCU. Another reactor can be added for onstream regeneration.

Distillate Desulfurization Unit

This unit is designed to remove 75 percent of feed sulfur . . . in blocked operation . . . from 4000 BPSD of FCCU light cycle oil, virgin wide-cut diesel oil, and virgin stove oil, all of which are made during high-sulfur crude runs.

Facilities include a reactor sized for light cycle oil HDS at 700 F and 500 psig. Double-bed design permits quenching during desulfurization. Cobalt moly catalyst is used. Also provided is a stripper to control product boiling range, a furnace, and two 50 percent single-stage reciprocating compressors used for feed gas plus recycle gas. The furnace is used for feed preheat during reaction and for steam-air preheat during blocked regeneration.

Plot space is provided for possible addition of a regeneration steam heater, a duplicate distillate desulfurizer reactor, and a gas scrubber to remove H_2S from recycle gas.

Besides treated oils, products are high-pressure separator gas, used for on-plot furnace firing only; stripper gas, sent to the FCCU gas compression system; and stripper gasoline. This gasoline goes to FCCU recovery when running light cycle, or to the crude unit overhead system when processing wide-cut diesel or stove oil.

Sulfuric Acid Alkylation Unit

Design alkylate production is about 1000 BPSD of aviation grade alkylate or 1050 BPSD of motor fuel blending component rated at 105-108 RON at 3.6 cc TEL. Olefin feed from the FCCU gas recovery section totals 1371 BPSD, including 390 bbl of butylenes, 190 bbl of propylene, and 310 bbl of isobutane. Isobutane deficiency in this stream is overcome by a crude unit-derived stream containing 391 BPSD of isobutane. Isobutane availability is thus adequate to alkylate all olefins and allow for fractionation losses.

The unit uses a Kellogg Cascade Model-B reactor. Vapor resulting from removal of the exothermic heat of reaction is compressed, condensed and the liquid returned to the reactor as refrigerant. This stream is predominately isobutane, but a portion is withdrawn and sent to the depropanizer to purge propane from the system. Towers include the depropanizer, a deisobutanizer, alkylate debutanizer, and a rerun unit to remove heavy polymer.

Crude and Product Treating

All crude oils are treated through a chemical desalting unit before charging to the crude unit. Organic salts removal is about 95 to 100 percent complete.

Catalytically cracked gasoline is caustic treated through an electrical distillate treater to remove sulfur and phenolic compounds.

Other lighter products are hydrogen treated, as described.

Tankage and Auxiliary Facilities

Crude oil supplies for the refinery come from Western Canada and initial transportation is through the Trans Mountain Pipe Line from Edmonton to Burnaby. Two miles of 12-in. branch line connects the main tank farm at Burnaby with the refinery. Equipped with a booster station, this line can supply 80,000 bbl of crude daily.

Storage tanks include 13 crude oil and product tanks, with 617,500 bbl total capacity. All are equipped with floating roofs. Tank levels and temperatures are indicated in a central control house, by means of dialing the tank number. Gasoline blending is handled by automatic facilities.

Electricity, delivered at 60,000 volts by the British Columbia Electric Railway, is lowered to 4160 volts by a 7500 KVA transformer at the refinery.

Steam is supplied by two 625 psi, 750 F boilers. One is conventional and can produce 81,500 lb of steam per hour. The other, a carbon monoxide boiler, obtains about 30 percent of its fuel requirement by burning FCCU stack gases to make 85,000 lb of steam hourly.

Water flows through some 20,000 ft of 10 to 14 in. mains laid through the city of Port Moody. System capacity, aided by two 125 hp booster pumps, is 3,500,000 gal daily. The cooling tower circulation pumps have a 25-million gal per day capacity.

Waste disposal design is predicated on eliminating all potential pollution hazards. Air pollution was studied by a leading expert who surveyed the site and submitted suggestions used in design of refinery equipment, including the smokeless flare.

Complete sewage systems are installed, including storm, domestic, oily water, and foul condensate sewers. The foul condensate is stripped of H_2S and other contaminants. An API-type separator removes most of the oil collected in the oily water sewer. The separator effluent is passed to a holding basin for final cleanup, then discharged through a 24-in. line extending 320 ft into Burrard Inlet. A special diffuser disperses it 25 ft below the surface.

B-A's Marketing Facilities in British Columbia

The new Port Moody refinery greatly augments B-A's already important West Coast operations. The company, which first entered British Columbia in 1935, now has about 550 dealers and service stations in the area, and an important marine business serving fishing fleets, lumber camps, and industries with a large tanker and some barges.

A mile from the refinery is the Port Moody bulk plant, which handles lube oils, greases, and drum goods of light oils. This plant is housed in the old Canadian Pacific Railroad ticket office, and the B-A dock was once used by sailing ships carrying steel to finish the railway line. Incidentally, Port Moody is the official western terminus of the CPR, completed in 1886. The line to Vancouver is rated as a "spur."

Construction Highlights

Plant construction was different from that of most refineries from the standpoints of accessibility, weather, and site preparation.

All material was trucked up a mile-long hill from a supply area on Burrard Inlet. Unusually heavy rainfall during the 1957-58 winter created such a quagmire that resident construction manager J. A. "Tex" Loep found the best way to get around was on horseback and kept several horses at the site.

Following clearance of trees, root systems, decayed vegetation, silt deposits and huge boulders from the 265-acre site, earth borings and contour maps were made to determine economic terracing.

An underground stream and several springs complicated the problem of water entering the southwest corner from Mt. Burnaby. A subsurface tile system resolved the underground water problem, while the water from Mt. Burnaby was diverted into a drainage canal dug along the western edge of the property to a wide gully at the northern corner.

Bitumastic lining was used for the first time to protect earthen structures such as the canal, ditches, dikes and holding basin from water erosion, particularly during heavy seasonal rainfalls. Water-flow areas not covered with bitumastic . . . a heavy prefabricated covering . . . were protected with specially treated wooden drainage flumes.

The sloping site requires that the process units and refinery building be terraced. The FCCU, for example, is terraced at elevation 498 ft, while the cat reformer is at the 512 level.

Despite days of continuous downpour in the 1957-58 winter, construction went ahead according to plan. During the spring months, the job moved several weeks ahead of schedule. In one month of peak construction, Canadian Kellogg achieved a safey record of 16,573 man-days free of accident. This won for them the British Columbia Centennial Safety Award Certificate.

Models a Valuable Design Aid

A model of the entire refinery was built, to a ⅜-in. to 1-ft scale by Kellogg's engineers. Measuring 6 by 25 ft, the five process units and steam plant required 14 model tables and four connecting aprons, to indicate grades and roads between adjacent sites. Even elevation differences for each unit were scaled.

The model was used to review and revise basic layout, major piping runs, platforms, ladders, stairways, access, equipment handling and conduits, and general maintenance and safety features. Photos of the model were distributed among B-A's home office and refinery site personnel, for study and review.

Model technique has progressed to the point where all project design work is done directly on the model without the help of drawings. The only piping drawings used are preliminary sketches covering features such as interior details, and the single-line isometrics are made by photos of the model, to expedite ordering and fabricating of piping.

Meet C. W. Coote, Refinery Manager

Plant manager C. W. Coote is a Western Canadian. He started with B-A in 1944, as a chemical engineer at Calgary refinery and has since served at the Turner Valley absorption plant and as manager of Calgary refinery.

Later, he was assistant manager of the company's Montreal refinery, and most recently headed the Edmonton refinery.

Before going to Port Moody, Coote worked at the head office in Toronto with the manufacturing engineering department, cooperating with them on the Port Moody plant design. The refinery thus incorporates many of his ideas and plans.

Acknowledgment

I thank British American Oil Company for having invited me to attend the dedication ceremonies at the Pincher Creek gas processing plant and at Port Moody refinery. It was a delightful experience. All photographs and the background material used for preparation of this article were provided by B-A. ★ ★ ★

This smokeless flare is 250 ft high and 42 in. diameter.

It's New

Refining - Processing Equipment

For Complete Information on Items Described Here, Use Enclosed Reply Card.

Nuclear Liquid-Level Gage

New gage measures the level of liquids in totally-enclosed containers. Radioactive source contained in a float follows the level of liquid. Radiation varies in intensity as the liquid level changes. Changes are detected by a scintillation device outside the tank which reads-out in linear distance or volume. *Radiation Counter Laboratories, Inc.*

Circle number (41) on reply card.

Force Balance Transmitters

New line of force balance transmitters measure and pneumatically transmit flow, differential pressure, level, and specific gravity. Minimum range span is 0 to 2 in. H_2O under pressures to 50 psig; maximum is 0 to 2000 in. H_2O under pressures to 5000 psig. Stability is maintained by new reset type booster relay. *Bailey Meter Company.*

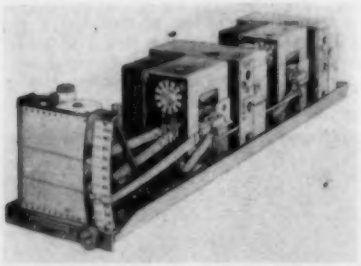
Circle number (42) on reply card.

Insulation and Jacket Combined

Calcium silicate pipe insulation and aluminum jacket come in single package and can be installed in one operation. Designed for temperatures up to 1200 F, insulation is made of 0.016 in. aluminum which has been combined with a vapor barrier, and then attached to sections of pipe insulation. Available in 36 in. section in sizes up to 24 in. pipe size by 3 in. thickness. *Johns-Manville Sales Corporation.*

Circle number (43) on reply card.

Two-Pen Electronic Recorder



All-electronic miniature unit records two variables on one chart. Optional feature: Control set point and/or alarm contacts for one variable. Record fits 5-in. square panel cutout, is housed in standard 24-in. deep panels. Sensitivity is 0.1 percent or better, accuracy is ± ½ percent of full scale. *Swartwout Company.*

Circle number (44) on reply card.

Absolute Pressure Transmitter

Accurate to 0.5 percent of full scale, new unit transmits absolute pressure measurements by producing 3 to 15 psi linear signal proportional to pressure. Measurement ranges are continuously adjustable between 0-50 and 0-250, or 0-200 and 0-850 of water, absolute. *The Foxboro Company.*

Circle number (45) on reply card.

New One-Piece Asphalt Carton

One-piece, sewn-bottom asphalt carton is designed to speed filling operations, reduce leaks, resist adverse weather condition, and save handling costs. Inside of carton is treated with new silicone release coating. Top flaps are optional. *Gaylord Container Corporation.*

Circle number (46) on reply card.

High Temperature Thermocouple

New thermocouple measures temperatures up to 2000 F at pressures up to 50,000 psi. This metal-sheathed, ceramic-insulated thermocouple is easily bent around twice its own diameter for use in tight places. *The Bristol Company.*

Circle number (47) on reply card.

Chromatograph Integrator

Automatically records on a strip chart up to 12,000 counts per minute per inch of chart. Mechanism features a new miniature integrator and is accurate to 0.1 percent full scale. *Disc Instrument Company.*

Circle number (48) on reply card.

Heat Media for Ebullient Cooling

A new heat-transfer material for use in ebullient cooling has been introduced. Dowtherm 209 also gives freeze protection in the engine and condensate return line. A 53 wt percent Dowtherm 209-water solution gives freeze protection down to about —45 F. *The Dow Chemical Company.*

Circle number (49) on reply card.

Computer Control System

Computer-directed process control system is built around a rapid-response digital computer. System offers full range of process control with capacity to accommodate expanding functions as new sensing and control devices and techniques are developed. Can be used in connection with existing equipment. *General Precision Equipment Corporation.*

Circle number (50) on reply card.

Power Recovery Gas Turbines

New line of process gas turbine-compressors has been developed for high-temperature power recovery. Turbine expands waste process gases at temperatures up to 1250 F, and the turbine-driven compressor delivers air to the process at pressures ranging from 30 to 200 psig. *Elliott Company.*

Circle number (51) on reply card.

Temperature Scanning Instrument

Digital variable indicator and temperature monitoring system scan thermocouples at a rate of 5 per second. If any thermocouples exceed preset common off-normal set point, the machines records this. If preset common alarm set point is exceeded, the system shuts down the plant. *Hagan Chemicals & Controls, Inc.*

Circle number (52) on reply card.

Hot Liquid Sample Cooler

Sample cooler provides constant analysis of boiler water or other heated liquid characteristics. Overall height of cooler is 7⅝-in.; outside diameter measures 4½-in. *The Bird-Archer Company.*

Circle number (53) on reply card.

Process Overheat Warning System

Continuous strip systems monitor temperature changes at every point on process vessels, etc. Thus, they pick up abnormal changes in large zones as well as localized spots. *Walter Kidde & Company, Inc.*

Circle number (54) on reply card.

Gas Analysis Thermatron

Instrument gives selective, continuous analysis of concentration of one gas in a multi-component mixture. Can be calibrated for any gas over narrow (0 to 1 percent) or wide (0 to 100 percent) ranges of concentration. Accuracy is within 2 percent of full scale. *Mine Safety Appliances Company.*

Circle number (55) on reply card.

Protection for Pressure Instruments

A low-pressure range protector is available for such instruments as incline manometers, draft gages, electrical pressure switches, and ultra-sensitive low-pressure transducers. Device will re-open after sealing at 2 percent below cut-off point. Available in four ranges, covering span of minus 15 psig to plus 85 psig. *Industrial Engineering Corporation.*

Circle number (56) on reply card.

Data Collection and Control System

New transistorized system collects data and remote-controls on-off devices. System consists of receiver console unit located at central operating point and field selector unit that can read and control 100 locations or be cascaded to control 1000. *Texas Instruments Incorporated.*

Circle number (57) on reply card.

New Refining Literature

Stainless Steel Fittings Catalog

New 86-page reference catalog gives detailed information on stainless steel pipe fittings, welding fittings, corrosion weight flanges. Welding data is included. *Ladish Company.*

Circle number (58) on reply card.

Building Plant Models

New catalog called "Designing in 3-D" contains instructions for assembling and description of parts and materials used in building process unit scale models. The finished design can be seen in realistic miniature before beginning details of drafting. *Scott Industries, Inc.*

Circle number (59) on reply card.

Forged Steel Unions

Simplified loose leaf catalog gives full information about forged steel unions and fittings. This 16-page folder contains detailed specifications on orifice unions, check valves, and forged steel fittings, ranging from 2000 lb through 6000 lb CWP. *Clayton Mark & Company.*

Circle number (60) on reply card.

Process Instrumentation Described

Eight-page 2-color bulletin describes process instrumentation and equipment. Included are operational data, design feature descriptions, and photographs of varied products for positive control of materials in motion. *B-I-F Industries, Inc.*

Circle number (61) on reply card.

Urea Processes Brochure

Four Montecatini-Kellogg liquid recycle processes for manufacture of urea for industrial or agricultural applications are described in new brochure. Process arrangement, flow sheets, material, and utilities balances are included. *The M. W. Kellogg Company.*

Circle number (62) on reply card.

pH Measurement Techniques

New data sheet covers techniques for making accurate pH measurements in emulsions, suspensions, and oils. Procedures are outlined step-by-step. *Beckman Instruments, Inc., Scientific and Process Instruments Division.*

Circle number (63) on reply card.

Rigid Aluminum Conduit Booklet

New 11-page booklet briefly outlines the mechanical and electrical advantages of aluminum rigid conduit. Also given are specific installation instructions and a comprehensive table of dimensions and weights of conduit, couplings, and elbows. *Aluminum Company of America.*

Circle number (64) on reply card.

Block Insulation Brochure

New 8-page color brochure contains detailed information on Abosite, an amosite asbestos-base block insulation. Included is data on strength, thermal efficiency, expansion qualities, and sizes available. *Aber Company, Inc.*

Circle number (65) on reply card.

Process Equipment Bulletin

A 16-page bulletin contains product description and specifications on line of chemical process equipment, including blenders, vacuum tumble dryers, packaged resin-distillation pilot plants, and process heat exchangers. *The Patterson-Kelley Company, Inc.*

Circle number (66) on reply card.

Thermocouple Catalog

New 36-page illustrated catalog gives data on thermocouple assemblies and pressure sealing glands and introduces new products by *Conax Corporation.*

Circle number (67) on reply card.

Manometer Catalog

Manometers for measuring pressure and vacuum in plants and laboratories are described in new 24-page catalog. Complete specifications are given. *King Engineering Corporation.*

Circle number (68) on reply card.

High Temperature Flowrator

Technical bulletin gives specifications on variable-area armored flowrator meter for high temperature applications, both gas and liquid. Included are operational limits, materials of construction, performance, capacity tables. *Fischer & Porter Company.*

Circle number (69) on reply card.

New Rust Treatment

Four-page folder describes a new liquid which stops rust action and, by chemically changing the rust to iron phosphate, prepares the surface for regular maintenance paint. *Rusticide Products Company.*

Circle number (70) on reply card.

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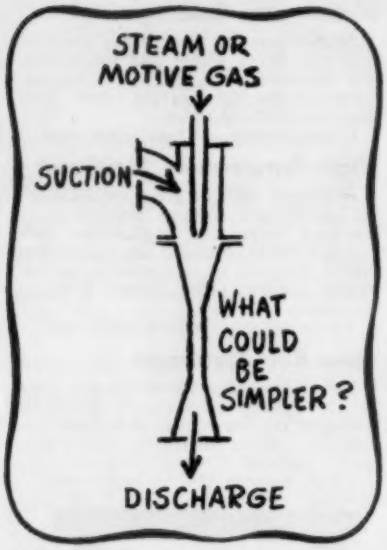

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New Literature

Aromatics Specifications

Brochure gives specifications for benzene, toluene, xylene, and various aromatic solvents. Composition data is also provided. *Vickers Petroleum Company, Inc.*

Circle number (71) on reply card.

Radiation-Resistant Chemicals

Physical properties of 9 organic chemical fluids which exhibit "outstanding" resistance to radiation and thermal damage are described in new booklet. *Monsanto Chemical Company.*

Circle number (72) on reply card.

Laboratory Supply Catalog

Revised 1273-page catalog of laboratory supplies and equipment is now available. Requests should be on company letterhead; mail directly to The Chemical Rubber Company, 2310 Superior Avenue, Cleveland 14, Ohio, mentioning *The Refining Engineer.*

Circle number (73) on reply card.

Silicone Antifoams Described

Brochure describes the chemical properties of silicone antifoams and outlines the nature of foaming systems. Trial samples of silicone antifoams also available. *Hodag Chemical Corporation.*

Circle number (74) on reply card.

Aluminum Weldor's Manual

Instructional information designed to train and qualify individuals in welding aluminum by the inert gas process is presented in new 144-page booklet. Free when requested on company letterhead; $1 per copy when requested for personal reference use. *Kaiser Aluminum & Chemical Sales, Inc.*

Circle number (75) on reply card.

Chromatograph Temperature Control

Temperature programming in gas and vapor chromatography is discussed in new 8-page bulletin. Subjects covered are column temperature, retention time, detector temperature, resolution, and temperature programming. *Burrell Corporation.*

Circle number (76) on reply card.

Computing Services

A 12-page brochure describes the many computing services offered by General Electric's Arizona computer department. Services include problem and mathematical analyses, programming and coding, machine time, training, and facility operation. *General Electric Company.*

Circle number (77) on reply card.

Liquid Level Gages & Valves

This 8-page, condensed catalog illustrates standard and special function gages and valves. It gives dimensional drawings, construction features, pressure-temperature graphs and ratings, materials, tables of sizes, specifications, and standard and optional features. *Jerguson Gage & Valve Company.*

Circle number (78) on reply card.

Improved Oil & Gas Burner

New bulletin describes an improved design for oil and gas burner. Most important feature mentioned is the location of the oil gun which makes it impossible for dripping oil to fall back into the gas burner. It is possible to observe and check the tip condition without shutdown. *John Zink Company.*

Circle number (79) on reply card.

New Polyglycol Booklet

A revised edition on polyglycol has been published. This 24-page booklet describes the various polyglycols, their properties and uses. Five new trihydroxy polypropylene glycols are included. *The Dow Chemical Company.*

Circle number (80) on reply card.

Glass Fiber Insulation

An 8-page folder describes new lightweight glass fiber pipe insulation for temperatures ranging from sub-freezing to 350 F. Folder emphasizes advantages, including "spring-hinge" opening and closing, ease of installation, cutting and fitting, and weight and insulating value of the insulation. *L. O. F. Glass Fibers Company.*

Circle number (38) on reply card.

Digital Control Computer

New brochure is available on digital computer control and data logging. Included in the bulletin is a description of the digital control computer as well as discussions of process control, data logging, pilot plant, and test facility applications for computer control systems. Computer can handle up to 1024 analog inputs and up to 128 analog outputs. *The Thompson-Ramo-Wooldridge Products Company.*

Circle number (39) on reply card.

Medium-Pressure Compressors

Bulletin contains design and construction data as an aid to proper selection and application of this equipment in a wide range of process industries. Full range of capacities from 1000 to 12,000 cu ft per min for pressures up to 15 psig is presented. *Roots-Connersville Blower Division, Dresser Industries, Inc.*

Circle number (40) on reply card.

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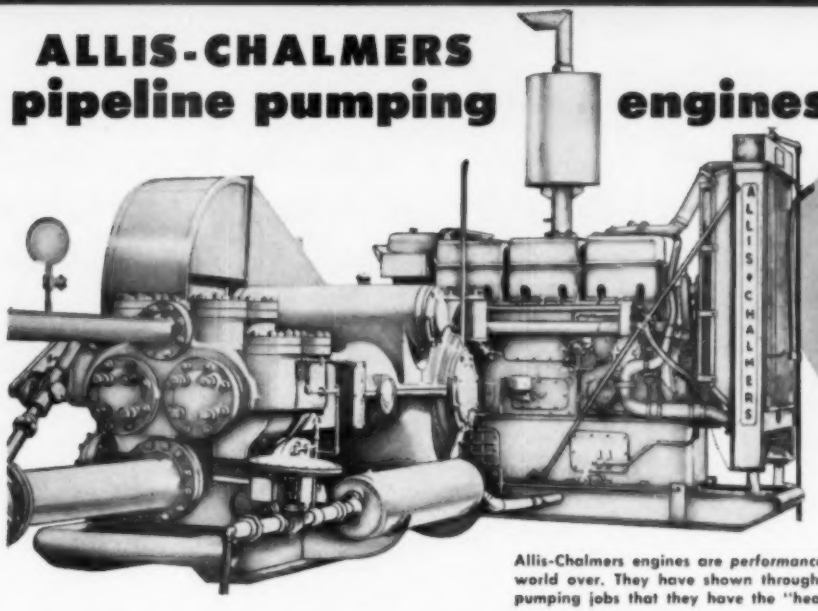

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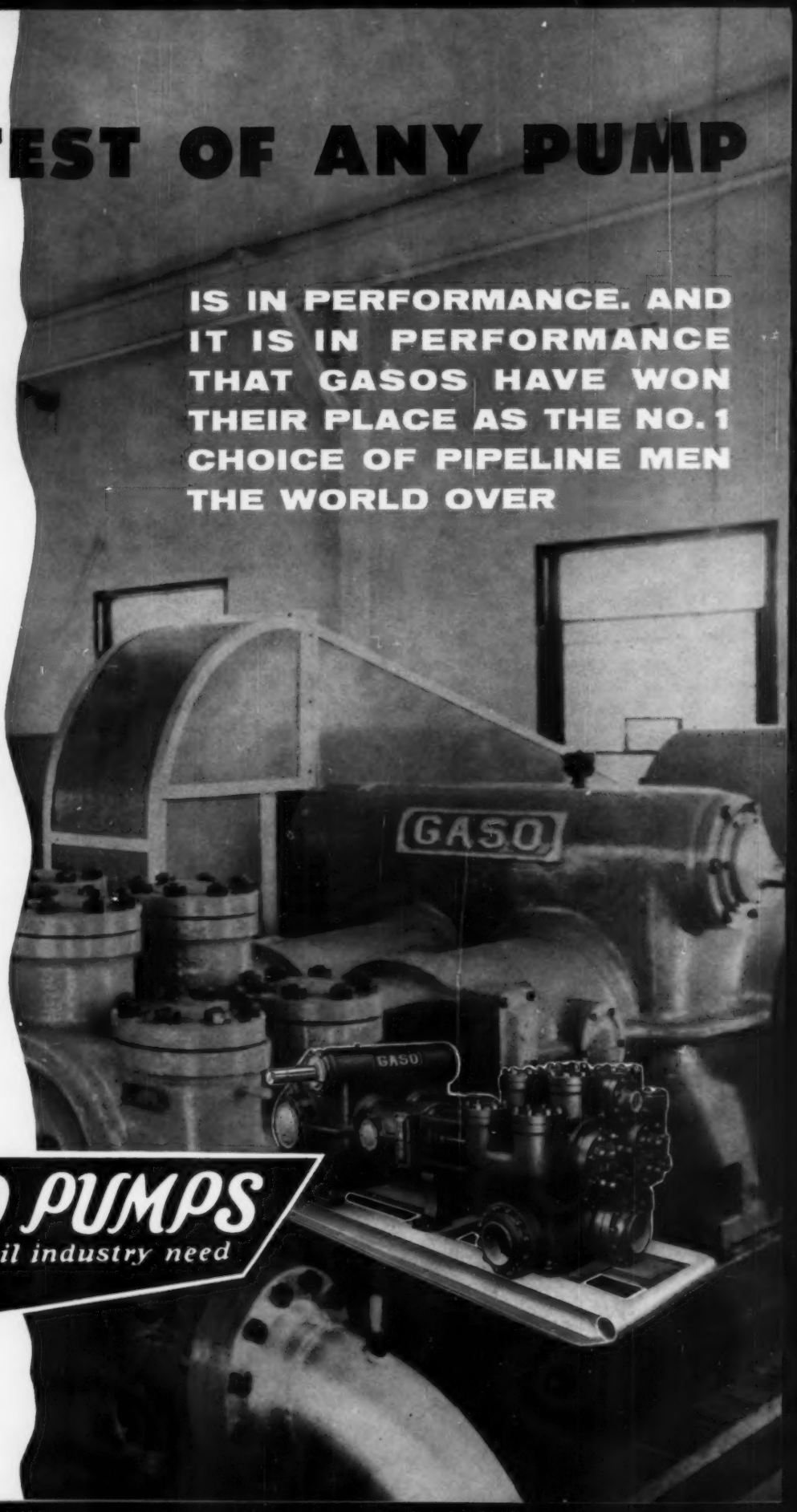

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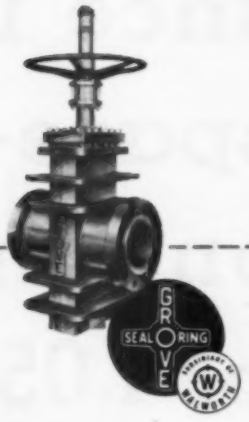

Lubrication problems are wiped out with the squeegee action of the exclusive Grove Seal-O-Rings. Up or down movement of the gate through the floating seats cleans and polishes both upstream and downstream surfaces. Foreign matter which could cause sticking, distortion, or abrasion is removed. The "O" Rings provide smooth action through the seats and bubble tight pressure seals on both sides of the gate. Specify Grove Seal-O-Ring Gate Valves. When they're set you can forget about lubrication or sealing compounds forever.

Grove valves never require lubrication

GROVE VALVE & REGULATOR COMPANY

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Even when it's being installed, an APCO Fin-Pak heat exchanger starts to save you money. That's because less than 500 man-hours are necessary to complete the job (for a 5,000 hp gas turbine). Then the Fin-Pak proceeds to cut fuel expense as much as 32%*. Maintenance is nil. It even saves space—400 cubic feet in one installation instead of 1,050

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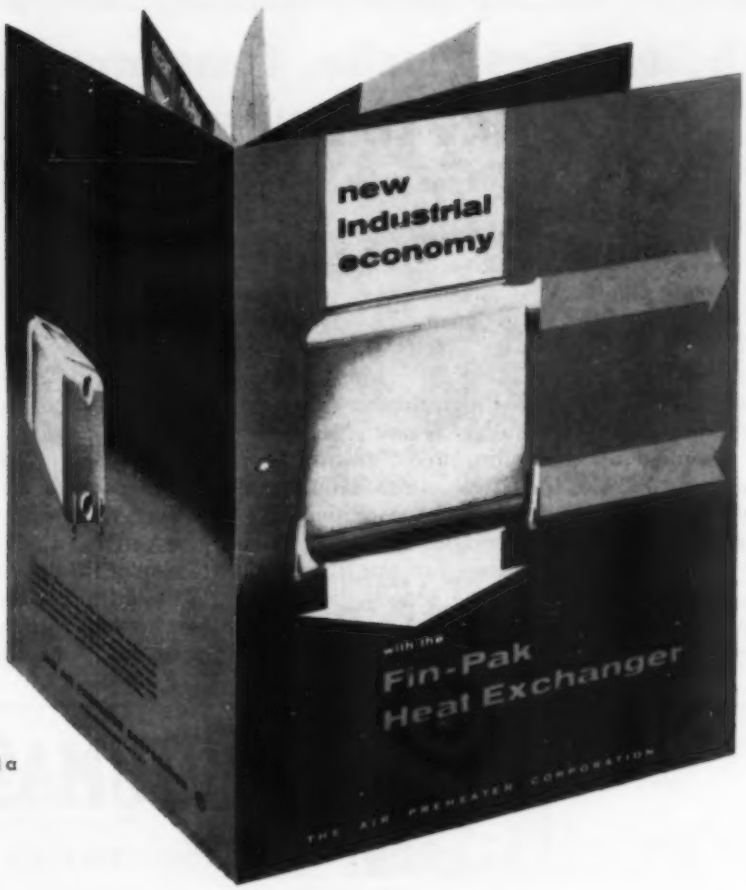
cubic feet for a tubular regenerator. If these facts suggest finding out more, get this new booklet from: Air Preheater Corp., 60 E. 42nd Street, New York, N.Y.



*At 1500 F, a 6-1 pressure ratio, and a designed effectiveness of 75%.

Natural Gas Pipeline Company of America Finds GAS LINE LIKE NEW AFTER 27 YEARS!

Bitumastic coal-tar enameled pipe to be re-used

In relocating its line to make way for a new highway near Truro, Iowa, the Natural Gas Pipeline Company of America removed some 900 feet of Bitumastic® enameled pipe laid in 1930. According to Mr. D. C. Allen, District Superintendent, this 24-inch seamless steel tubing is in such good condition that it will be reconditioned and used again as new pipe.

Applied by the rolling and "granny-rag" method in 1930, the Bitumastic XXH Enamel on this line was in excellent condition. The asbestos-felt overwrap, originally applied loose, was torn from soil stresses, but the Bitumastic enamel coating showed no serious disbonding or deterioration. At the time of relocation, the section had been under cathodic protection for two years. Natural Gas Pipeline Company of America records show no corrosion leaks on this section during the entire 27-year period underground.

Case histories such as this from prominent pipeline companies prove the unmatched protective ability of coal-tar enamel. In these days of rising material costs, you can't afford to gamble your entire pipeline investment on a less effective coating.

Your Koppers representative will be glad to give you full information on the superior protection of Bitumastic coal-tar enamels. Koppers District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh, and Woodward (Birmingham), Alabama.

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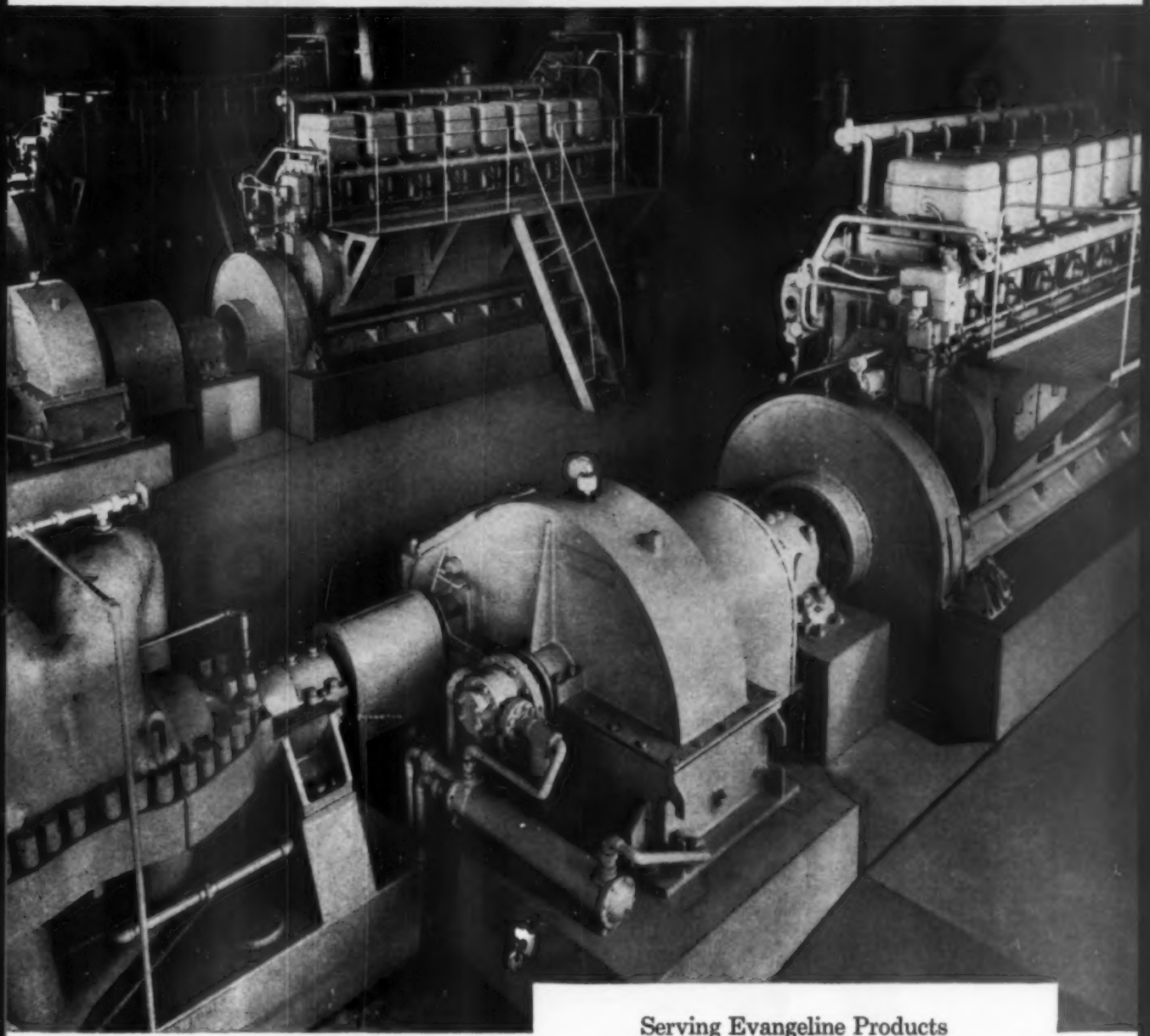
NORDBERG ENGINES FOR PIPE LINES



Serving Evangeline Products Pipe Line System satellite stations

Unattended operation and remote control of six Nordberg engine-pumping units is the feature of the Evangeline Products System's expansion. Nordberg 1720 hp, four-cycle *Supairthermal*® 8-cylinder engines are installed in two identical, full satellite pumping stations on this 16-inch products pipe line.

SEND FOR NEW PIPE LINE BOOKLET
Illustrating the application of Nordberg engines on crude, products and gas pipe lines, and graphically describing Nordberg's facilities and ability for producing these heavy duty prime movers.

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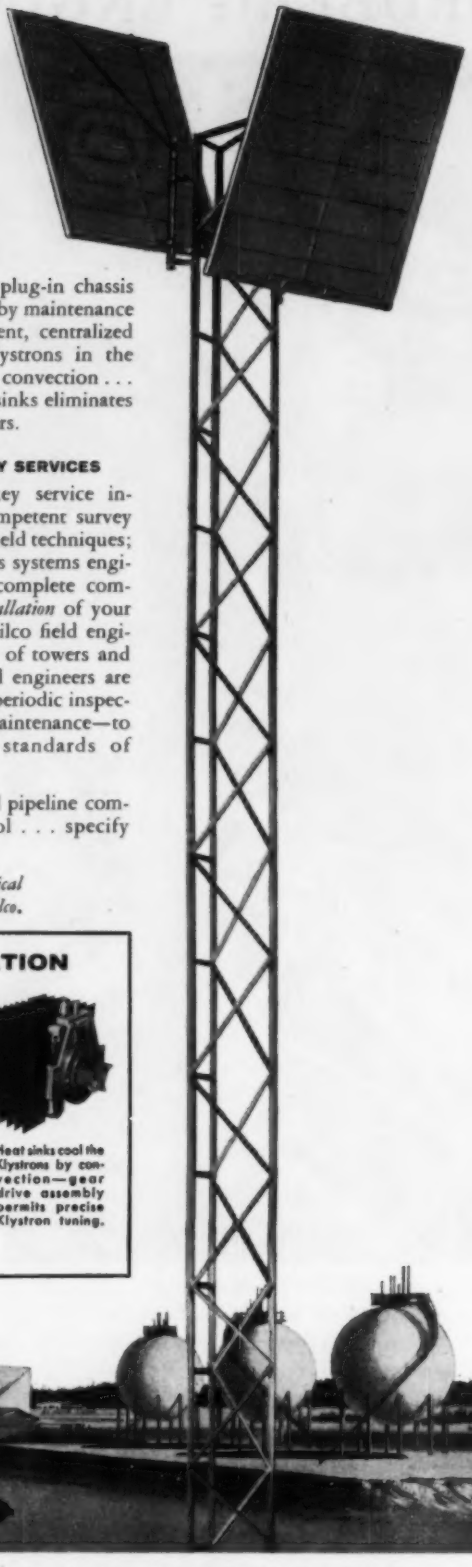
Reliable, unattended microwave operation for pipeline communications and control!



Philco CLR-9 microwave delivers outstanding system reliability, economy of installation and operation, simplified equipment maintenance for dependable pipeline communications. With 240 voice channel baseband capacity—for telephone, telemetering and remote control—and capability for handling high-speed computer data transmission—Philco microwave fills both immediate and long-range requirements of modern pipeliners.

Philco's new CLR-9 microwave equipment provides high channel density, duplex communications with integrated standby facilities for maximum system reliability. It is designed for quick installation in standard relay racks . . . and engineered with built-in metering and test facilities plus plug-in chassis for easy field maintenance.

Performance reliability is sharply increased in the new CLR-9 by the use of tubeless power supplies—new semiconductor rectifiers replace tubes. The use of printed wiring panels increases circuit stability—and complete plug-in chassis may be quickly removed by maintenance personnel (permits efficient, centralized depot maintenance). Klystrons in the new CLR-9 are cooled by convection . . . the use of compact heat sinks eliminates the need for bulky blowers.

PLUS PHILCO'S TURNKEY SERVICES

Philco's complete turnkey service includes—*site surveys* by competent survey engineers experienced in field techniques; *system planning* by Philco's systems engineers who design your complete communications system; *installation* of your microwave system by Philco field engineers—including erection of towers and shelters; and, Philco field engineers are available for *field service*—periodic inspection and preventive maintenance—to maintain the highest standards of system performance.

For reliable, unattended pipeline communications and control . . . specify Philco microwave.

At Philco, opportunities are unlimited in electronic and mechanical research and engineering • Look ahead . . . and you'll choose Philco.

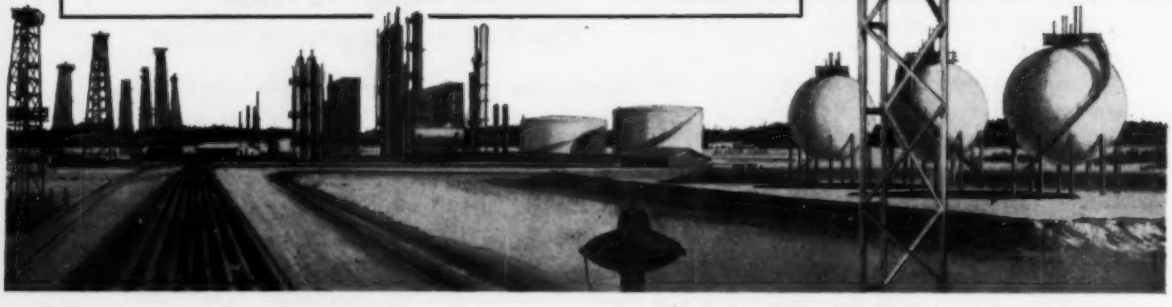
NEW PHILCO CLR-9 MICROWAVE STATION

The CLR-9 terminal consists of wave-guide assemblies, master control, tubeless power supplies and plug-in chassis for IF assembly, baseband drop, modulator, reflector control and servo.

Rugged printed wiring panels increase circuit stability and simplify maintenance.

Heavy-duty, tubeless power supplies increase reliability by employing semiconductor rectifiers—assures maximum reliability and minimum maintenance.

Heat sinks cool the Klystrons by convection—gear drive assembly permits precise Klystron tuning.



PHILCO.

Government & Industrial Division

4718 Wissahickon Ave., Philadelphia 44, Pa.

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Considerable underground station piping, sump tanks, and main line valve and scraper trap risers, along Plantation Pipe Line Company's new 18-inch line from Baton Rouge, Louisiana, to Helena, Alabama, were coated with Roskote A-51 for corrosion protection—chosen for its resistance to accidental exposure to petroleum products.

ROSKOTE MASTIC A-51 fully protects your underground metal even if exposed to petroleum products

Like all Roskote pipe mastics, this new oil and gasoline resistant coating is cold-applied by brush, spray or the Roskoter annular applicator. Roskote A-51 is a time-proven provider of high electrical resistivity and protection against corrosion by acid or alkali. Its fast drying permits prompt backfilling.

Effective above or below ground, A-51 provides superior cathodic insulation and protection against corrosive influences for other metal structures at terminals, bulk stations, natural gasoline plants and refineries. For complete technical data and prices, write the nearest Royston office.

Royston Laboratories, Inc.
Box 112-G, Blawnox, Pittsburgh 38, Pa.

BRANCH OFFICES IN ATLANTA, CHICAGO, HOUSTON, PHILADELPHIA, SAN DIEGO AND TULSA. WAREHOUSED IN NORTHEAST, SOUTHEAST, NORTH CENTRAL AND SOUTH CENTRAL REGIONS.

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...because he is using Westinghouse Visicode® Supervisory Control. He knows that when he wants the equipment to work, it can be depended upon...that its check-back system virtually eliminates the possibility of making an error.

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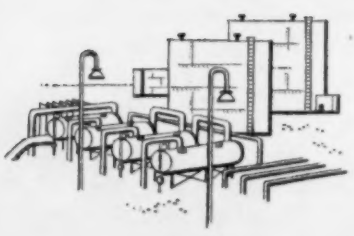
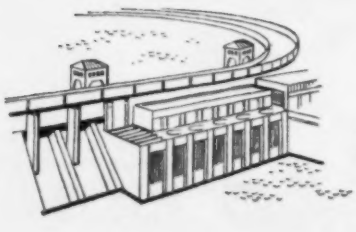
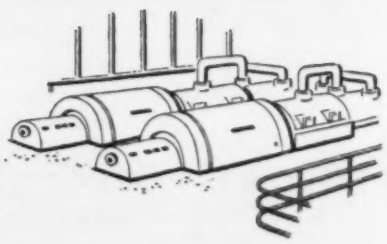
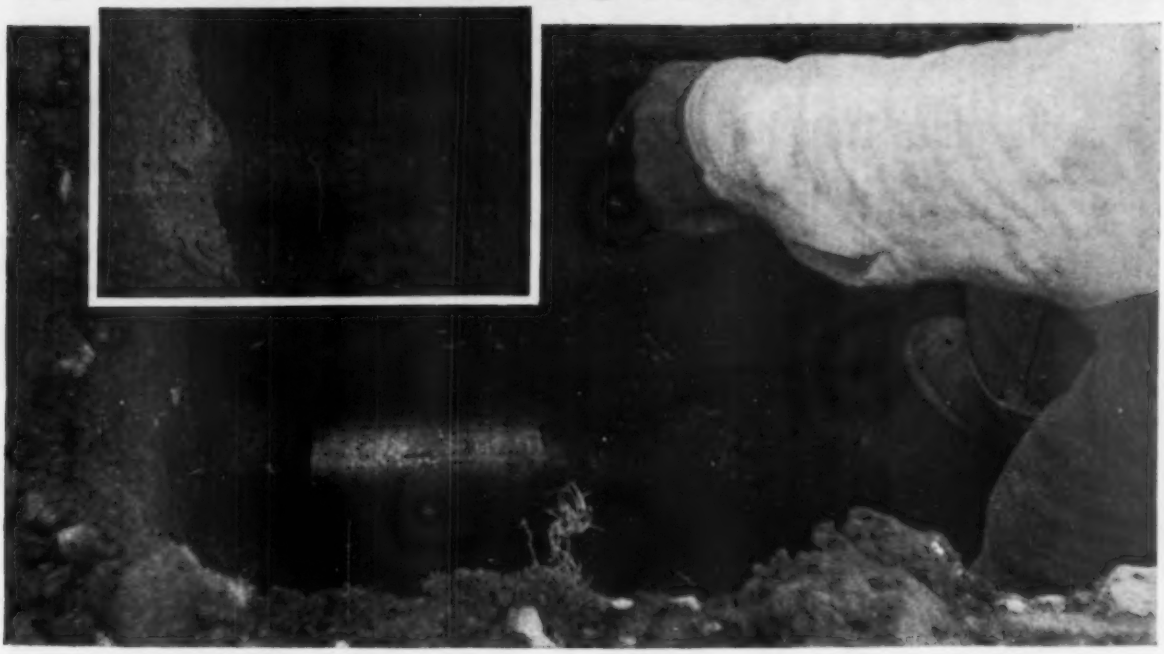
YOU CAN BE SURE...IF IT'S Westinghouse







17-YEAR PROTECTION RECORD!



Year After Year...More Evidence Proving That TAPECOAT Adds Years of Service Life to Gas Lines Underground or Under Water

Right across the country, TAPECOAT installations prove that you get more for your money when you measure pipe protection with a calendar.

Since this cost-cutting coal tar coating in tape form was first introduced in 1941, it has demonstrated its ability to withstand severe conditions underground or under water. TAPECOATED lines dug up after 17 years of service show no signs of deterioration on the pipe.

Typical is the experience of a utility in a coastal area. For a thorough trial, this company applied TAPECOAT in areas where severe corrosive conditions were known to exist. The lines were dug up this year and, after years of service under severe conditions such as brackish waters and corrosive soil, the pipe showed no signs of corrosion, proving the quality of TAPECOAT protection.

In terms of preventive maintenance and replacement costs, performances like this emphasize the most important consideration in buying protection. Remember, TAPECOAT is a hot-applied coal tar coating in tape form—designed for lasting protection on pipe, pipe joints, service connections, mechanical couplings, fittings, insulated lines, tanks, tie rods, and other steel surfaces vulnerable to corrosion.

TAPECOAT comes in rolls of various widths and is available in asphalt. Where primer is desired, specify TC Primecoat, the compatible coal tar primer.

A TAPECOAT sales and service engineer is always available to help you on any corrosion problem. Write for complete details today!

The TAPECOAT *Company*

ORIGINATORS OF COAL TAR COATING IN TAPE FORM

1533 Lyons Street, Evanston, Illinois

REPRESENTATIVES IN PRINCIPAL CITIES

CLEVELANDS

dig more trench more dependably year after year after year

THE CLEVELAND 92—for field, lease, water lines, digs to 20" wide, to 5' deep.

THE CLEVELAND 110—for all types of smaller lines, digs to 24" wide, to 5½' deep.

THE CLEVELAND 140—the leader in its field for 20 years, digs to 30" wide, for pipe up to 22" diameter.

THE CLEVELAND 240—fits pipeline jobs of all kinds, digs 20" to 36" wide, to 6'3" deep.

THE CLEVELAND 320—the ultimate for pipeline trench, digs 22" to 52" wide, to 7½' deep, digs for 36" pipe.

PROVED on thousands of miles of pipeline work of all kinds throughout the world

Good Everywhere

The CLEVELAND TRENCHER Co.

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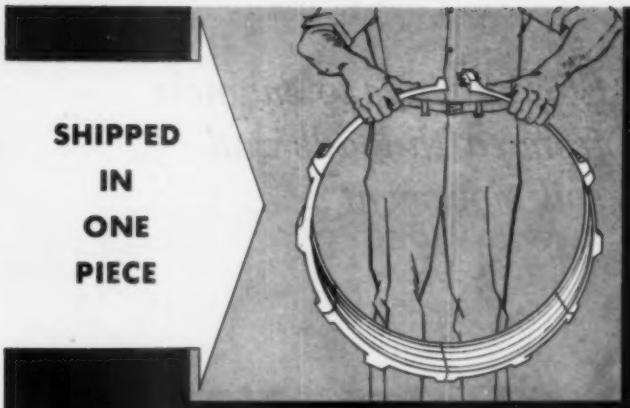

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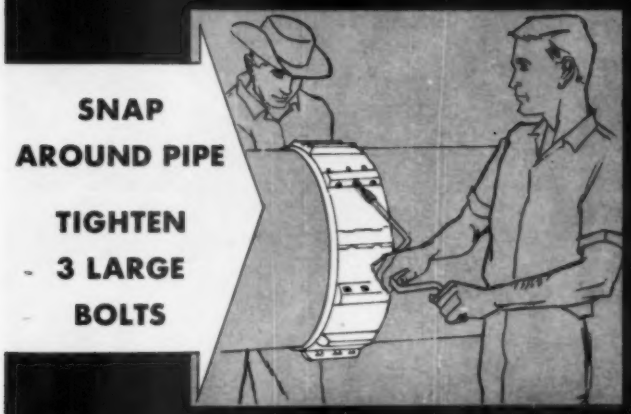
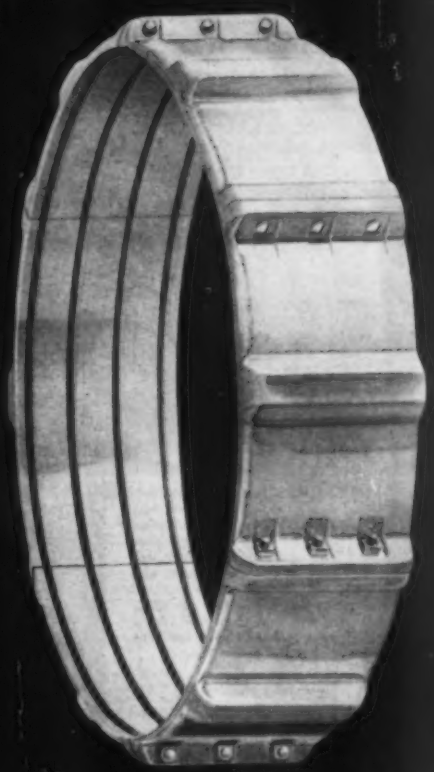


SNAP AROUND PIPE

TIGHTEN 3 LARGE BOLTS

IT'S A 'SNAP' FOR BIG-INCH PIPELINES

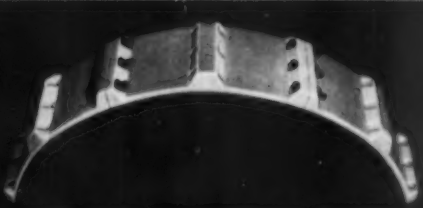


WmSON "M-2" PLASTIC THINSULATOR®

ALL SIZES: 16" & LARGER

- **HIGH COMPRESSIVE STRENGTH**
  UNIT LOADING IN EXCESS OF 8,000 POUNDS
- **TREMENDOUS IMPACT STRENGTH**
  HIGH DUCTILITY PREVENTS FRACTURING
- **MINIMUM WEAR** "LUBRICATED" THINSULATOR
  SLIDES EASILY THROUGH LONG CASINGS

TOUGH AS A BOOT . . . HERE'S PROOF!



SNAPS BACK TO ORIGINAL POSITION

Write for literature on all sizes

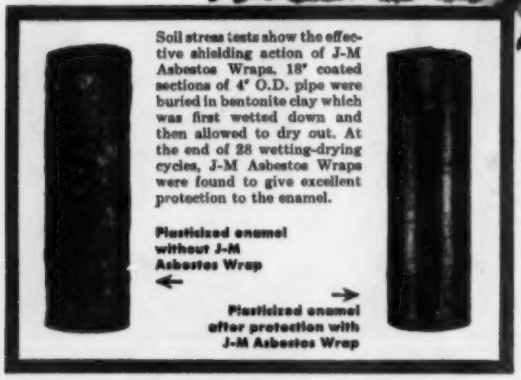
T. D. Williamson, Inc.

P. O. BOX 4038 TULSA 9, OKLAHOMA

REPRESENTATIVES: HOUSTON • AMARILLO • PLAINFIELD, N. J. JOLIET, ILL. • JACKSON, MICH. • LONG BEACH • SAN FRANCISCO BARTLESVILLE, OKLAHOMA • SEATTLE • SALT LAKE CITY EDMONTON • TORONTO • VANCOUVER • BUENOS AIRES MONTERREY AND MEXICO CITY • CABIMAS, ZULIA VENEZUELA DURBAN, NATAL S. AFRICA • PARIS, FRANCE • SYDNEY, AUSTRALIA

Stop damage to enamels from earth loads and soil movement...

Johns-Manville Asbestos Wraps are available in 3 types for field application or mill wrapping.



Soil stress tests show the effective shielding action of J-M Asbestos Wraps. 18" coated sections of 4" O.D. pipe were buried in bentonite clay which was first wetted down and then allowed to dry out. At the end of 28 wetting-drying cycles, J-M Asbestos Wraps were found to give excellent protection to the enamel.

Plasticized enamel without J-M Asbestos Wrap ←

→ **Plasticized enamel after protection with J-M Asbestos Wrap**

Get lasting protection with tough, strong J-M Asbestos Wraps

Extensive research and field tests conducted by a leading firm of consulting engineers have demonstrated the effects of soil movement and earth loads on pipeline enamels. They show how the forces of the soil tend to distort and induce thin spots that weaken the protective coating . . . permit corrosion of the pipeline.

The same research and field tests also demonstrated that J-M Asbestos Wraps provide the strong protection that strong coatings need and deserve. "Asbestos Wraps offer the most effective single protection against damage —prolong the working life of pipeline enamels." Here's why . . .

Asbestos is an ageless mineral. Fibers of asbestos are strong and tough . . . cannot rot or decay. As used in J-M Wraps, the fibers are felted, then impregnated with a coal tar or asphalt saturant to form literally a flexible covering of stone. These "stone-like" qualities form a durable shield—protect pipeline enamels from earth loads and soil movement which weaken coatings and permit pipe corrosion to set in.

Pipeline engineers are invited to write for their own copy of PP-34A, a *3-Point Study of Pipeline Coatings and Wrappers*, at no cost or obligation.

Johns-Manville, Box 14, New York 16, N. Y.
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SPECIAL DESIGN PORTABLE METER CALIBRATING TANKS

Tanks shown are part of a shipment to a major oil company's terminals in the Midwest. These tanks are specially designed with triangular frame and caster wheels so they can be moved easily by one man in the terminal loading rack area. Warner Lewis Company welcomes the opportunity to submit designs to meet **your** special requirements. Write for complete information.

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Men like JOHN WACHUCK make the difference!

He conditions the pipe for coating! But, don't worry, John Wachuck knows exactly what his Roto-Grit blast machine can do. His fingertips control millions of tiny steel grits that "scrub" the pipe silver-bright so the coatings will bond perfectly! John, and the men who work with him, are your best guarantee of Hill-Hubbell craftmanship. Their skill assures you of consistent quality!

When pipe is coated and wrapped, it calls for the precision of factory-application and factory-control

Specify Hill-Hubbell wrapped pipe on your next job

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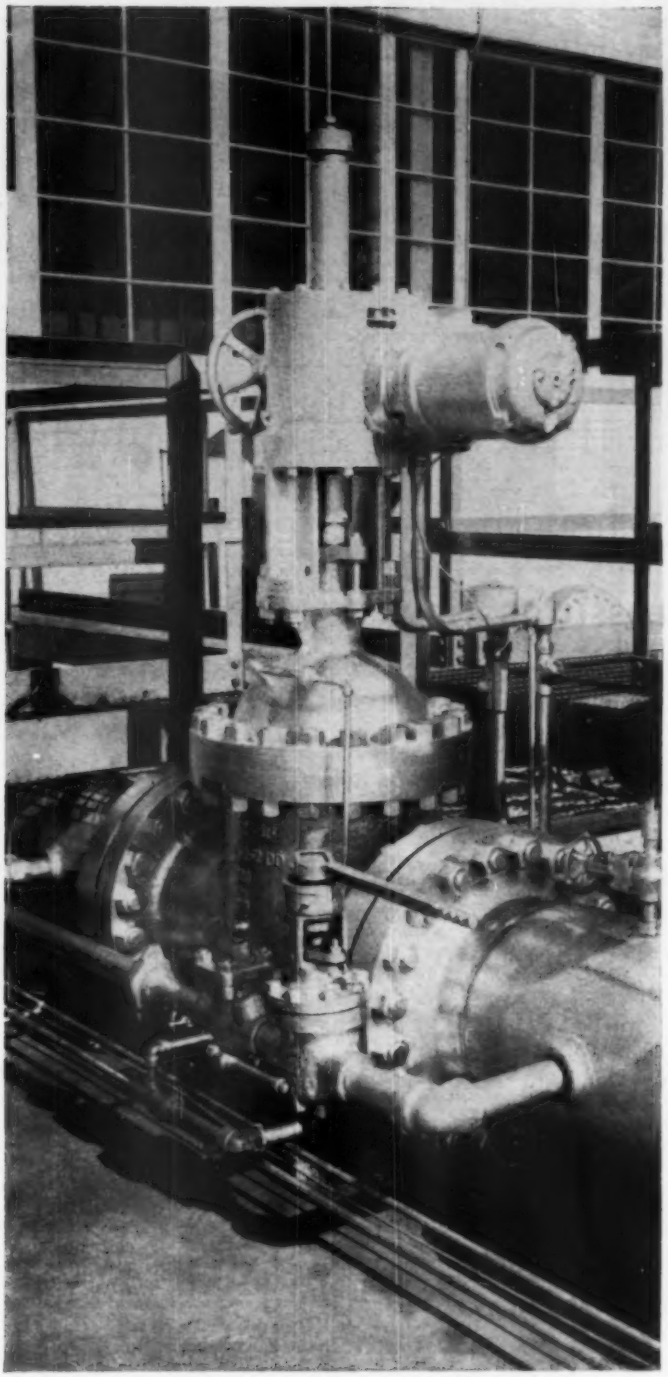
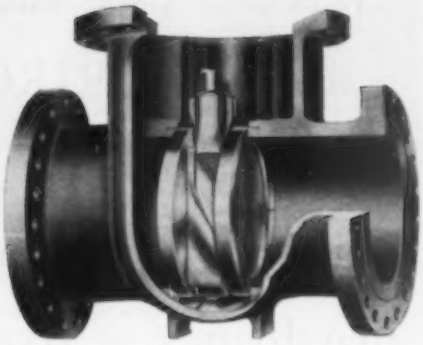


DARLING

fully-revolving double disc
pipe line gate valve



IDEAL FOR EFFICIENT CONTROL

Here's why

Operation is *consistently* trouble-free! Minimum friction, easy opening and closing, with self adjustment for positive closure. Wedging principle automatically compensates for any body deflection. Fully revolving discs avoid wear concentration. Discs and seats wipe clean with each operating cycle. In short . . . prolonged high efficiency with an extreme minimum of attention. It will pay you to give us an idea of your service needs and get specific details.

DARLING VALVE & MANUFACTURING CO.

Williamsport 2, Penna.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

DARLING
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VALVES

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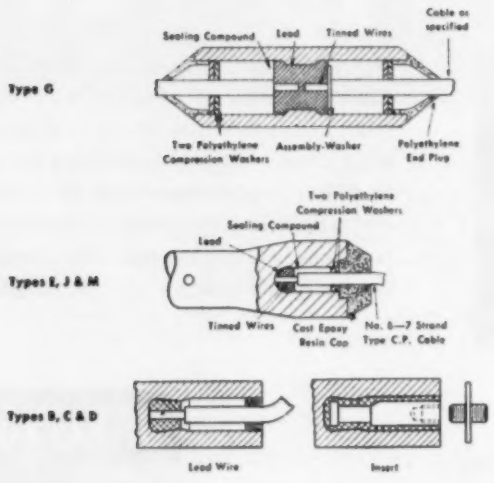
DURIRON® IMPRESSED CURRENT ANODES

For more positive cathodic protection of all types of structures used throughout the petroleum industry, insist on DURIRON® ANODES. Duriron performs as well as graphite in all the easy services, and far outperforms graphite when the going gets tough in marshlands, at river crossings, or wherever it is impractical to use backfill. Duriron anodes have proven their superiority for the protection of pipelines, drilling rigs, well casings, storage tanks, and similar structures. For real protection, get Duriron.



STANDARD ANODE SIZES

Type Anode	Size	Area Sq. Ft.	Weight (Lbs.)	General Application
B	1" x 60"	1.4	14	Fresh Water
C*	1½" x 60"	2.0	25	Ground Bed
D	2" x 60"	2.6	46	Ground Bed
E	3" x 60"	4.0	115	Salt Water
G	2" x 9"	0.4	5	Ducts
J	3" x 36"	2.5	80	Salt Water
M	2" x 60"	2.8	57	Salt Water

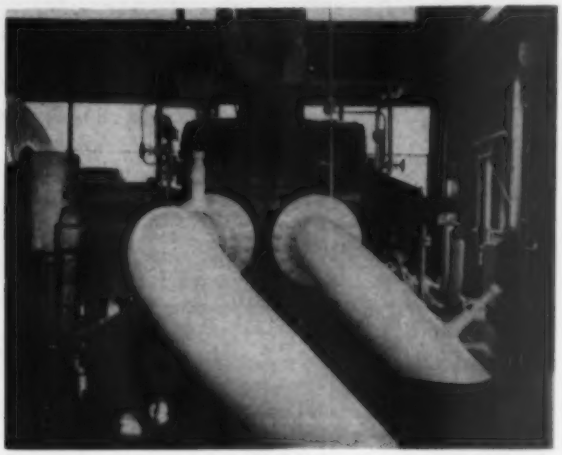
*Applicable also in fresh water service. Should not be used in ground beds without backfill.

THE DURIRON COMPANY, INC. / DAYTON, OHIO

DURCO

GRAPHIC ENGINEERING DIGEST

View from compressor building operating floor, showing compressor at right center, with portion of the gas turbine prime mover on the left. Seal oil tank is mounted on top of the compressor (painted white), along with level controls and supply piping to the unit. Compressor gas discharge flanges at the right.



Compressor viewed from the discharge side, showing both discharge flanges. Coupling to turbine is at the left, with seal oil pump on extension of shaft at extreme right.

Series-parallel centrifugal compressor brings flexibility

Robert E. Schuhmann *Trunkline Gas Company, Houston, Texas*

A NEW CENTRIFUGAL COMPRESSOR that is basically *two* compressors in one case has an unprecedented flexibility and high efficiency; moreover, it is fully able to cope with the widely varying operating throughputs that are typical of cross-country pipelines today. The new unit is the result of a combined effort of engineers with Trunkline Gas Company and De Laval Steam Turbine Company.

The new compressor has four impellers mounted on a single shaft with two suction and two discharge connections on opposite sides of the case. It can be operated as (1) two parallel (two-impeller) compressors or as (2) two compressors in series with gas piped through all four wheels.

This new design enabled Trunkline to capitalize on the many advantages of the gas-fired turbines, which are able to run for long periods of time with little attention or maintenance. The weak point of the gas turbines in the past has been that the single centrifugal compressor did not have the operating range to compare with a reciprocating compressor, and in a series installation it required wheel changes to follow changing pipeline conditions.

Trunkline's gas-turbine, centrifugal compressor stations at Edna, Kountze, and Premont, Texas, compare with any reciprocating station. They are highly flexible and capable of operating efficiently over the normal range of compression ratios from 1.2 to 1.75. Their performance, initial cost, fuel, labor, downtime, and total cost of ownership compare favorably with reciprocating stations. In addition, units can now be installed in parallel with each other and a station expanded indefinitely, exactly the same as with reciprocating engines.

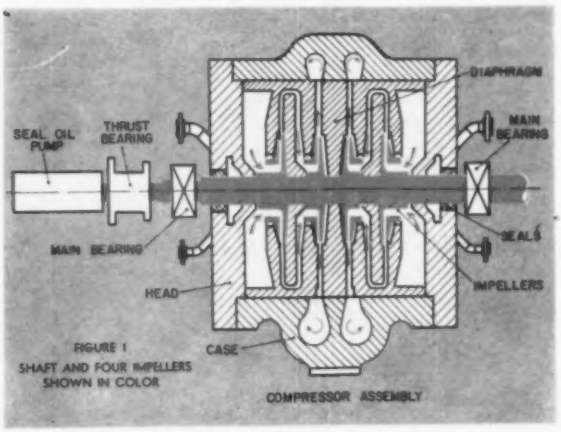
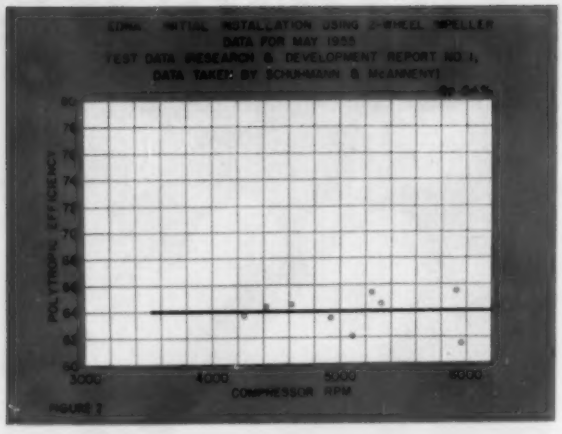


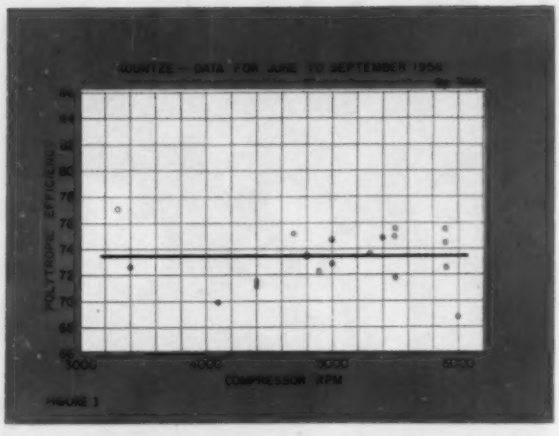
FIGURE 1
SHAFT AND FOUR IMPELLERS SHOWN IN COLOR

Physical Description

The feasibility of building this unit and achieving the necessary compression ratio using only two wheels of large diameter and high specific speed was first examined, tested, and eliminated before settling on four wheels of slightly smaller diameter. This final design then permitted:

1. A low specific speed.
2. Small pressure rise per wheel, 82 psi average at the station design point of 1.57 compression ratio.
3. Low Mach number of impeller rim, 0.44 at maximum speed and compression ratio.
4. A nearly linear relation for rate of increase of impeller flow area with radius of impeller, cited by some designers as necessarily constant.
5. A reasonably large clearance (0.25 in. on the radius) between impeller and diffuser ring, though set by some designers at as much as one-tenth of the diameter. Axial clearance on high-pressure side of impellers is ⅜ in., whereas clearance on low-pressure side is ⅛ in.
6. A vaneless diffuser.
7. A total unit weight of 59,000 lb.





Construction of Unit

Sole plate—8 ft, 10 in. wide by 9 ft, 5½ in. parallel to shaft.

Face-to-face distance on flanges 9 ft, 6 in.

Flanges 16 in. ASA 600 octagonal groove ring joint.

Unit set on 2 ft, 3 in. pedestals on the sole plate and shimmed.

Emergency seal oil tanks mounted on top of compressor, 8 ft long by 2 ft OD.

Overall height of unit including tank 11 ft, 3 in. approximately.

Flanges spaced 32 in. OC at 2 ft, 9 in. center line above top of sole plate.

The dual impeller design first investigated had a polytropic efficiency of some 60 to 65 percent, as compared with the four impeller unit efficiency of about 74 percent, all other things remaining constant. (See Fig. 2 and 3 showing test data). Present polytropic efficiency of near 80 percent is attributed to a revision, after installation, of the sealing system. These efficiency results were determined from the equation:

$$\frac{T_2}{T_1} = \left[\frac{P_2}{P_1}\right]^{\frac{n-1}{n}} \quad \ldots\ldots\ldots \quad (1)$$

Where:

T_2 = compressor discharge temperature, R
T_1 = compressor suction temperature, R
P_2 = compressor discharge pressure, psia
P_1 = compressor suction pressure, psia
n = polytropic exponent

and solving for the exponent n; then using the equation:

$$e_p = \frac{k-1}{k} \cdot \frac{n}{n-1} \quad \ldots\ldots\ldots \quad (2)$$

Where:

k = ratio of specific heats
e_p = polytropic efficiency

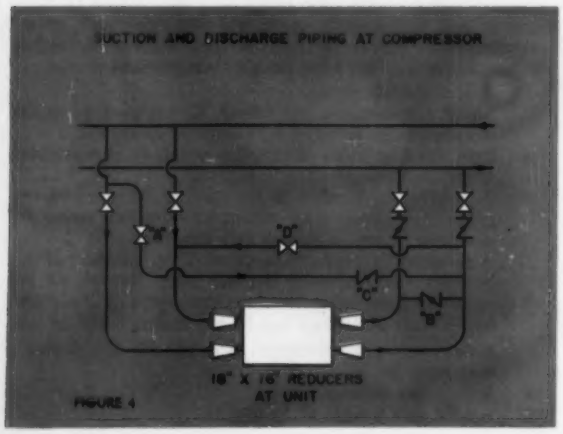
with all pressures and temperatures known from test.

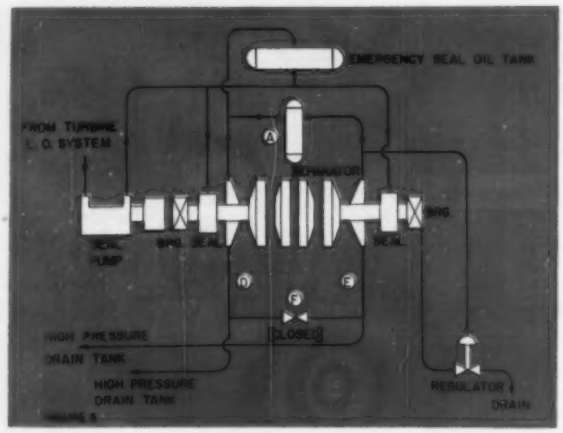
The increase in polytropic efficiency with the sealing system revision was achieved by eliminating internal gas leakage from the seal on the higher pressure side to the seal on the lower pressure side. More about this later.

Placing the two suction and two discharge nozzles on opposite sides of the unit simplifies external piping. (See Fig. 4.) Suction and discharge compressor loading valves are 18-in. plug valves actuated by piston driven gear and rack operators. This facilitates remote power operation of the unit from the control room, at the option of operating personnel. Two 18-in. check valves in the discharge piping provide a safeguard against destructive surges.

An additional safeguard provided to protect seals and the diaphragm between the two stages, is the 2-in. pressuring valve marked as "A" in Fig. 4.

Internal flow is such that the gas path is from the outer head toward the middle of the case, with the impellers of the two stages placed back to back. This keeps the lowest pressures on the shaft seals, and minimizes the differential across the diaphragm separating the two stages. Less pres-





sure differential means less leakage through the labyrinth; thus polytropic efficiency is higher.

Impellers are 25 in. OD, giving a tip speed of 643 fps at 5900 rpm. Diffuser is vaneless type, 25½ in. ID and 38 in. OD. Shaft is stepped in diameter to avoid critical frequencies. Standard labyrinth is found between all impeller stages. Diaphragm is a nearly flat cast-steel disc, 3⅜ in. thick at the labyrinth near the shaft, widening out and cored near the outer diameter.

Main bearings are 2¼ in. long by 4¾ in. diam, babbited sleeve bearings. The Kingsbury thrust bearing is set outboard of the main bearing, on the high-pressure side of the compressor case. A 5-in. bearing first tested failed from overload. A 7-in. bearing was substituted, and it has run satisfactorily with only normal wear for 23,000 operating hours.

Since the single case houses all impellers, the unit requires only two shaft seals. This is probably optimum for the size and speed of the unit, since an overhung impeller would have presented other difficulties. As it is, the main seal oil pump can be directly shaft driven.

Seal System

With regard to the seal system, Trunkline uses two different methods. One is to draw gas from the high-pressure side to the low-pressure side, such that both seals see a fluid pressure in the intermediate range between second stage and first stage suction. With the compressor operating in parallel, of course, there would be no bleed of gas at all. The second method is to control the oil pressure supplying the seals and simply let the seals operate at the two pressure levels of second and first stage suction. These methods are illustrated in Fig. 5 and 8.

An interesting series in design aspects was developed at Trunkline in completing these stations. When the first of Trunkline's three centrifugals was installed in early 1955, the first system tested was the same as the simplified schematic shown in Fig. 5 with the exceptions that the equalizing line separator at "A" and the valve at "F" were not included. The object of these equalizing connections from one seal drain chamber to the other was to equalize the downstream pressure on both seals, which had a common oil supply, yet retained different gas pressures. Two-inch line "A" initially carried 3 or 4,000,000 std cu ft per day, resulting in a higher brake horsepower per million standard cubic feet per day compressed, as well as lower polytropic efficiency than necessary. This system also resulted in high seal oil losses. Without this equalizing line, however, two entirely separate seal systems would be required, including pumps, controls, and emergency tanks.

Trunkline engineers and operating personnel then installed the centrifugal separator "A" and valve "F," which recovered from 20 to 80 percent of oil lost from the seal system. Pressure regulators in both oil supply and gas lines could have done the same thing. Test data shown in Fig. 6 and 7 show results of installing valve "F" and separator "A," respectively.

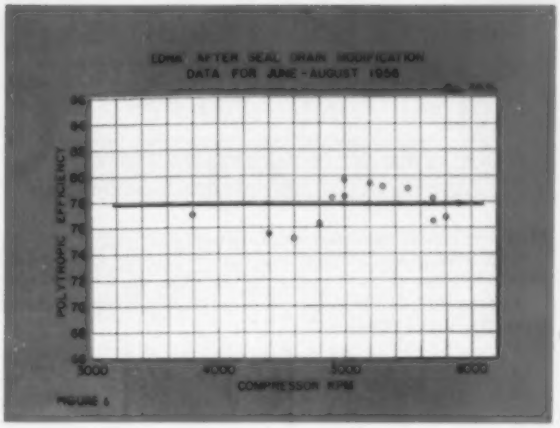
It is to be noted here that the spread of points in Fig. 2, 3, 6, and 7 should not be considered too serious as a 1 percent error in the ratio of specific heats or the polytropic exponent "n" can cause a 3¼ percent error in the calculation for polytropic efficiency. This possibly could be another reason why the adiabatic efficiency is the value usually referred to for comparisons.

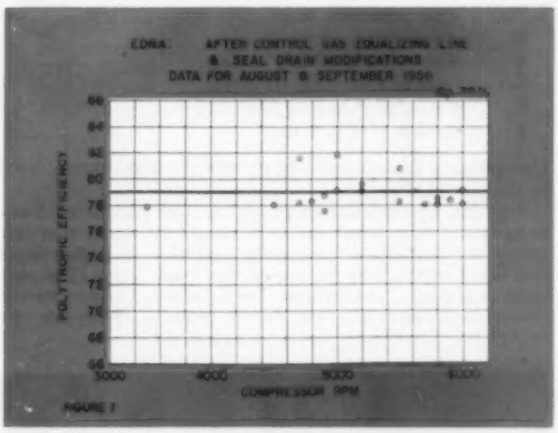
A further modification of the seal system is shown in Fig. 8. Oil flow from high to low-pressure side is controlled by "R," which senses pressure difference across the high-pressure seal. The regulator is a fail-safe instrument, providing oil to the lower pressure seal and main bearing. Regulators "B" and "C" provide back pressure on the seals and main bearings, the oil being the same for all services. The results of this modification lowered oil consumption on the compressor and turbine prime mover to about 1 gal of oil per 50,000 brake hp hr. The seals are spring loaded carbon rings located outboard of labyrinth glands.

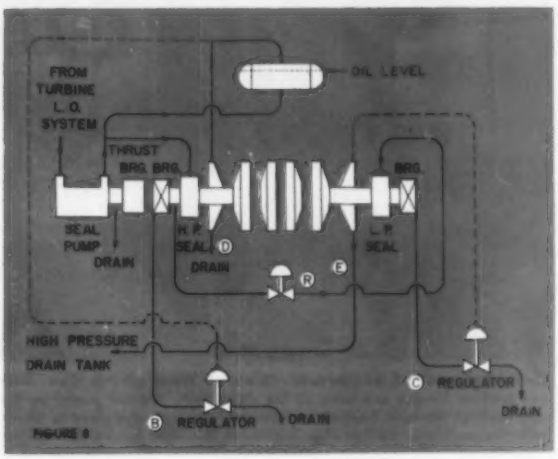
Performance of Unit

Specifications

Normal discharge pressure	900-1000 psig
Capacity in series, at best efficiency point	208 MMSCFD
Capacity in parallel, at best efficiency point	600 MMSCFD
Normal compression ratio range, at best efficiency point, in series	1.28 to 1.67
Normal compression ratio range, at best efficiency point, in parallel	1.12 to 1.3







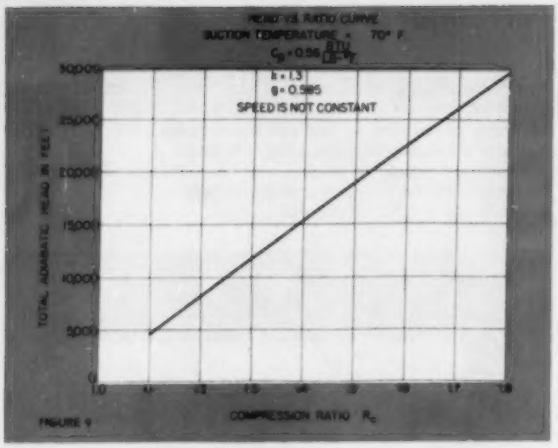


FIGURE 9

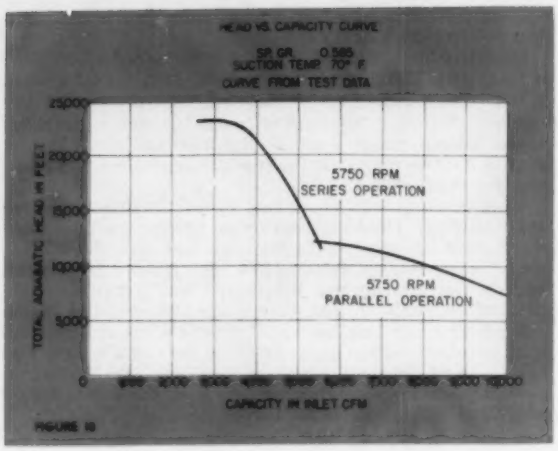


FIGURE 10

Maximum compression ratio range,
with inlet guide vanes . . . . . 1.08 to 1.82
Maximum speed . . . . . 5900 rpm

The head vs compression ratio curve, Fig. 9, is calculated from the usual equation:

$$H_{ad} = \frac{RT_1Z}{\frac{k-1}{k}}\left[\left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} - 1\right] \quad . \quad . \quad . \quad (3)$$

Where:

H_{ad} = total adiabatic head
R = gas constant = 89.23
Z = supercompressibility factor
K = ratio of specific heats = 1.3
P_2 = discharge pressure, psia
P_1 = suction pressure, psia

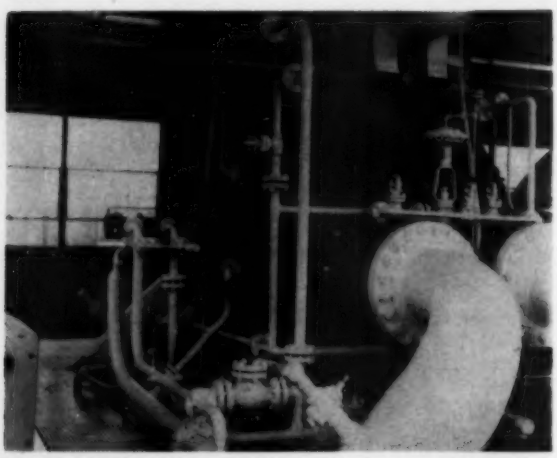
Compression ratio = ratio of P_2 to P_1, as customarily used in the gas industry.

Fig. 10, the head-capacity curve, was plotted to show comparison with other units. It should be noted that this curve can be shifted toward the direction of higher head and lower capacity by the use of inlet guide vanes. This was done at Station 8 at Premont, Texas, where a higher station discharge pressure at lower flow is required. With this one exception, Trunkline's units are identical.

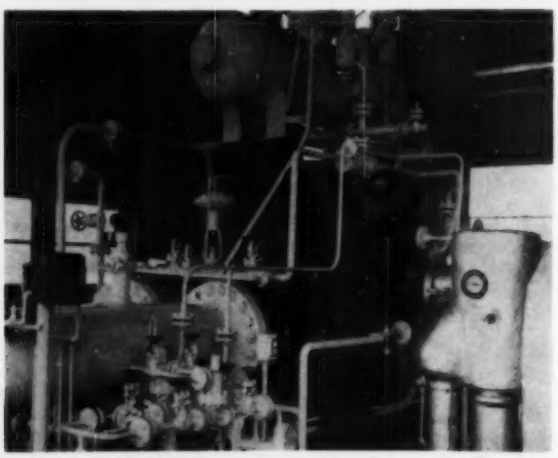
The adiabatic efficiency by heat balance is shown in Fig. 11. Also shown is an operating comparison with reciprocating compressors.

The advantage of the series-parallel machine is that the plane of operation is greatly enlarged as compared with that of a single-stage machine. The BHP/MMSCFD compressed curve would be a family of curves similar to Fig. 11, for varying efficiencies. Actually, to achieve this wide band of operations and be capable of operating alongside reciprocating compressors, the impeller design must of necessity be something of a compromise, and yet the efficiency at low ratios is seen to be even higher than many reciprocating compressors. Efficiencies shown on Fig. 11 are seen to be among the highest values of points plotted on Fig. 7, and occurred in the drafting procedure of fairing the curves. The data is considered to be still within the accuracy of test and calculation procedures.

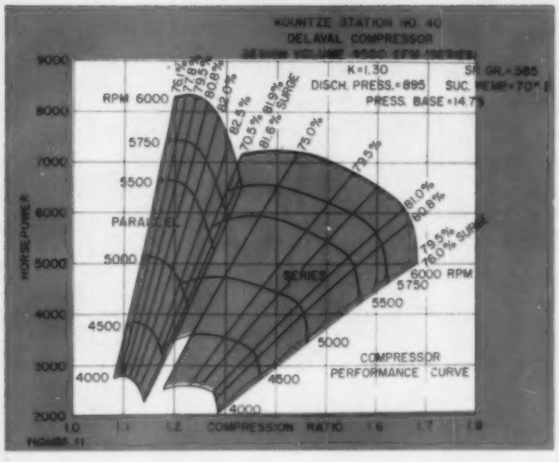
System flow plotted against compression ratio presents the inherent match of a centrifugal compressor to a pipeline, the pipeline flow being plotted with the Panhandle Equation. Fig. 12 shows such a plot, where constant compressor efficiency conforms very closely to a pipeline curve. As additional pipeline loop is added for a station, the compressor performance is still within the bounds of pipeline flow even though at different efficiency. Where this machine has its advantage, of course, is for pipeline capacity to increase to the extent of high efficiency operation for the compressor



Outboard end of compressor viewed from suction side. Both gas suction flanges are seen at the right, with seal oil pump on the unit shaft at the left. Seal oil and control gas piping is painted white, with the regulator "R" of Fig. 8 seen at the right above the suction flanges.



Inboard end of compressor viewed from suction side, with prime mover off to the right. The back pressure regulators at lower left are the seal oil control seen as regulators "B" and "C" of Fig. 8.



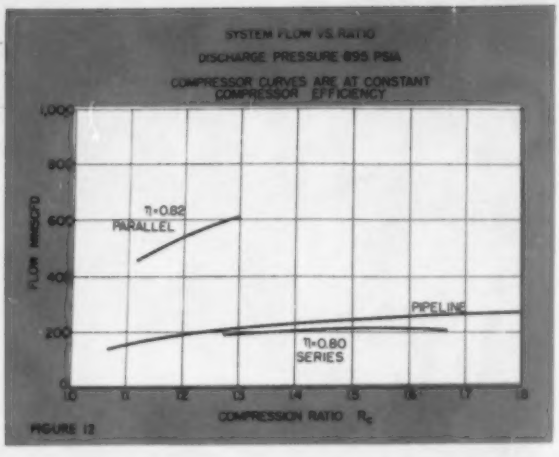


FIGURE 12

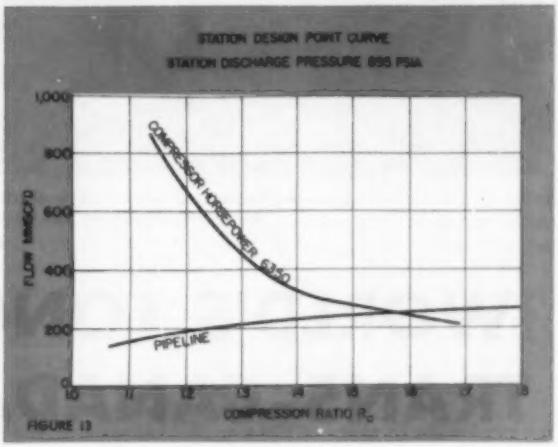


FIGURE 13

About the Author

Robert E. Schuhmann is a supervising engineer with Trunkline Gas Company of Houston, Texas. Prior to joining Trunkline he served as an engineer with Tennessee Gas Transmission Company. He is a graduate of the University of Texas where he obtained both a BS and MS in mechanical engineering. He was an instructor in mechanical engineering at his alma mater for two years following graduation. Schuhmann is past president of the Pipe Liners Club of Houston, a member of ASME, and National Society of Professional Engineers.

in parallel. For simplicity, only two efficiency curves are plotted in this illustration, since in reality the major portion of the field is covered, as shown in Fig. 11, above. In operation, then, as the pipeline dispatcher varies flow in the system, the compressor operating point will very nearly move down a constant efficiency line. Curves shown are plotted for convenience for a constant station discharge pressure, so if that pressure changes then the curves merely shift relative to the ordinate.

In overall gas transmission system design, families of curves similar to Fig. 13 are usually constructed; intersection of pipeline and compressor curves determine design operating point. These curves, of course, have the same general characteristics regardless of compression type used. With the series-parallel unit, however, as opposed to single wheel centrifugals, the compressor operating range is extended into the lower compression ratios (below 1.3). This development was made in large diameter large clearance reciprocating compressors eight years ago by Burt Mast, who is now credited with the fundamental concept on these centrifugal units also. Thus, as seen in this figure and perhaps as easily by reference to Fig. 11, this design for centrifugal compressors enables the prime mover to be fully loaded down to very low operating compression ratios.

Compendium

The first of these units has now operated very satisfactorily on the Trunkline Gas system for more than three years, and proved sufficiently good in its development that two additional units were built in 1955, all at different stations. Since our first modification of the compressor seal oil and control and equalizing gas line systems, these units have operated since the summer of 1956 with no down-time attributed to the gas compressors. Total operated hours since that time are:

Station 8 at Premont	14,600 hr
Station 23 at Edna	15,000 hr
Station 40 at Kountze	14,200 hr

At this writing there has still been no interruption of these operating hours, with the exception of the equalizing line regulator (seen on Fig. 8) installation at Kountze, although that was scheduled down-time. All other down-time at these stations has been scheduled maintenance and inspection on the turbine prime movers or other station facilities.

Cost

Installed cost to build a station comprising this type unit is found from experience to be exactly the same as for performing the same function with any other type compressor and prime mover combination. Cost to install this single compressor itself is undoubtedly less than two separate units to do the same job. With station operating costs (the sum of fuel, labor, etc.) also the same, then the cost of ownership for this station equipment is obviously the same as for reciprocating equipment.

Acknowledgment

The author wishes to acknowledge the help received in preparation of illustrations on performance test data from Adrian W. McAnneny, supervising engineer for research and development at Trunkline Gas Company, and development data from C. R. Carter and K. A. Hamilton, superintendent of compressor stations and field superintendent, respectively.

This is a Graphic Engineering Digest of a paper presented at the Annual Petroleum Mechanical Engineering Conference of the American Society of Civil Engineers, Denver, Colorado, September 21-24, 1958.

★ ★ ★

Timber and rock typify much of the terrain through which Trans-Canada line passes. This photo was taken near Bernard Lake in northern Ontario.

WORLD'S LONGEST GAS LINE— TRANS-CANADA—IS COMPLETED

Canada's biggest job of year, windup of 2200-mile Trans-Canada System, beset with many construction obstacles

Leslie Orr Rowland

WITH 12 MAIN LINE spreads at work all through the summer of 1958, the world's longest natural gas pipeline has now been completed for its entire distance of 2200 miles from the Alberta-Saskatchewan boundary to Montreal. This is the system of Trans-Canada Pipe Lines, Ltd.

Work this year included a substantial distance being laid for Northern Ontario Pipe Line Crown Corporation, a public company owned jointly by the Dominion and Ontario governments but leased by Trans-Canada with an option to purchase, which Trans-Canada has said it intends to take up shortly in order to bring the overall system under its sole ownership.

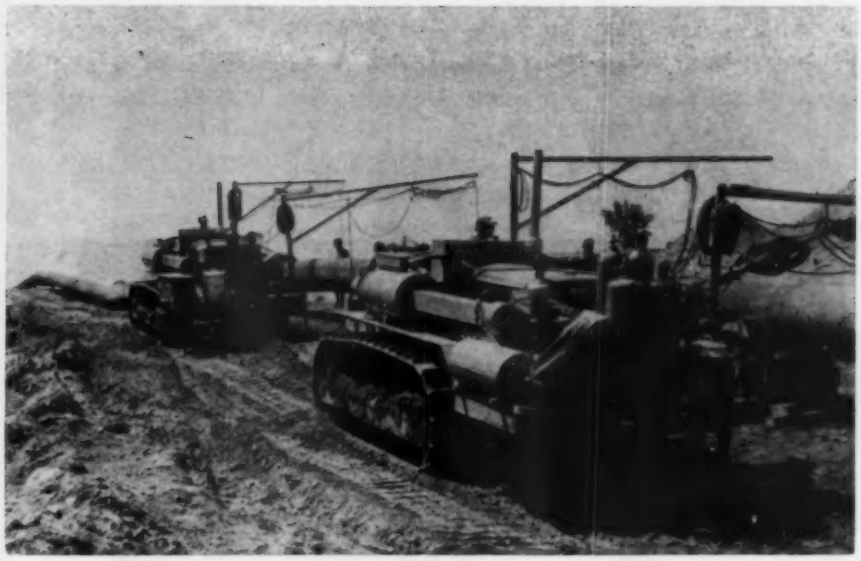
Of the work done this year, seven spreads were on that portion of the line through central and southern Ontario built directly for Trans-Canada. Combined contracts totaled 486 miles. The other five spreads worked for the Crown corporation, laying a total of 367 miles across the rock, muskeg, and clay belts of northern and northwestern Ontario.

The combined total of 853 miles of 30-in. pipe is by far the largest indivi-ual construction job of the current season in Canada and ranks among the largest contract jobs ever handled for one owner in one construction season in Canadian pipelining history.

Crown Line Starts Early

On the Crown line section, an early start was organized, so that the difficult job of clearing and grading right-of-way through extremely tough terrain could be done during the winter when access to the right-of-way in muskeg areas was easy because of frozen ground on which vehicles could travel. The five contracts were awarded last November 18, numbered Spreads V to Z inclusive, starting at Port Arthur in northwestern Ontario where the 1957 construction schedule of the Crown corporation terminated, and running northeastward to the pulp mill town of Kapuskasing where the publicly-owned line reached its final milepost and the privately owned line resumed its advance toward southern Ontario.

Spread "V," comprising 63.6 miles, started at the west bank of the Current River, a few miles north of Port Arthur, and terminated at the south bank of the Nipigon River near the town of



Twin arc-welding units near Trout Creek.

Nipigon. This portion of the right-of-way is largely hard granite rock, necessitating a great deal of drilling, which was done in two stages: First to grade the right-of-way into suitable condition for ordinary travel, and second to shoot the ditch. The job was awarded to Nelen, Ltd.

Spread "W" consisted of 48.1 miles, starting at the north bank of the Nipigon River and running northeast to the town of Beardmore. It covered the distance between Milepost 374.5 and MP 422.6. The skip of 0.2 mile is accounted for by the Nipigon River crossing, which was let separately. It is also nearly all solid granite rock, which has been described by experienced contractors who battled with it last year as "the core of the earth." The job was let to Morrison-Shivers, Ltd.

Spread "X" constituted 70.9 miles from Beardmore to a point 6 miles east of the lumber and paper mill town of Longlac. This section goes through a transition from a small amount of granite rock at the west end to clay belt terrain with some muskeg toward the east end. The contract was awarded to Majestic Contractors, Ltd.

Spread "Y" was in the wilderness for most of its 91.3 miles, starting at the termination point of Spread "X" and finishing at a point approximately 30 miles west of the mining town of Hearst. For its entire length there is no named settlement, and there is no accessible rail point on the section because of the muskeg terrain. However, the right-of-way parallels closely the hardsurfaced trans-Canada highway, and this provided reasonably good access. This is the only section on the entire combined construction schedule where the contractor was compelled to work out of a mobile trailer camp, because there were no public accommodations within a reasonable distance of the job. The contract was awarded to Canadian River Construction, Ltd.

Spread "Z" contained 92.9 miles, starting at MP 584.8 and terminating at MP 677.7, the end of the Crown line, which started at the Ontario-Manitoba boundary. Its point of termination is the west bank of the Kapuskasing River at the town of Kapuskasing. Largely clay belt farming country, the terrain presents no serious problems. The contract was let to Mannix Company, Ltd.

Extremely wet weather during most of the summer played havoc with construction schedules because of the high water table, the extra soft and wet condition of the muskeg, and shutdowns due to rain. There also was an extra heavy snowfall in the region last winter, and this made it impossible to get on the right-of-way as early as the contractors had hoped. Clearing and grading was done through snow, and some rock drilling for right-of-way went on during the latter part of the winter, but actual pipelaying did not begin until near midsummer. Spreads made a mile a day average on days worked.

Muskeg terrain, which comprises such a large portion of the two longest sections, was largely conquered by the practice of building up a high riprap roadway during the winter and early spring, before the right-of-way had thawed out from its winter freeze-up. This greatly speeded both stringing and laying of pipe, compared to what the experience would have been if the contractors had tried to lay pipe by conventional means through the soft and sometimes bottomless natural terrain.

Trans-Canada — Seven Spreads

On the privately owned line, the seven sections were designated as Spreads 8 to 14 inclusive, resuming the numerical system that was used on Spreads 1 to 7 in western Canada last year.

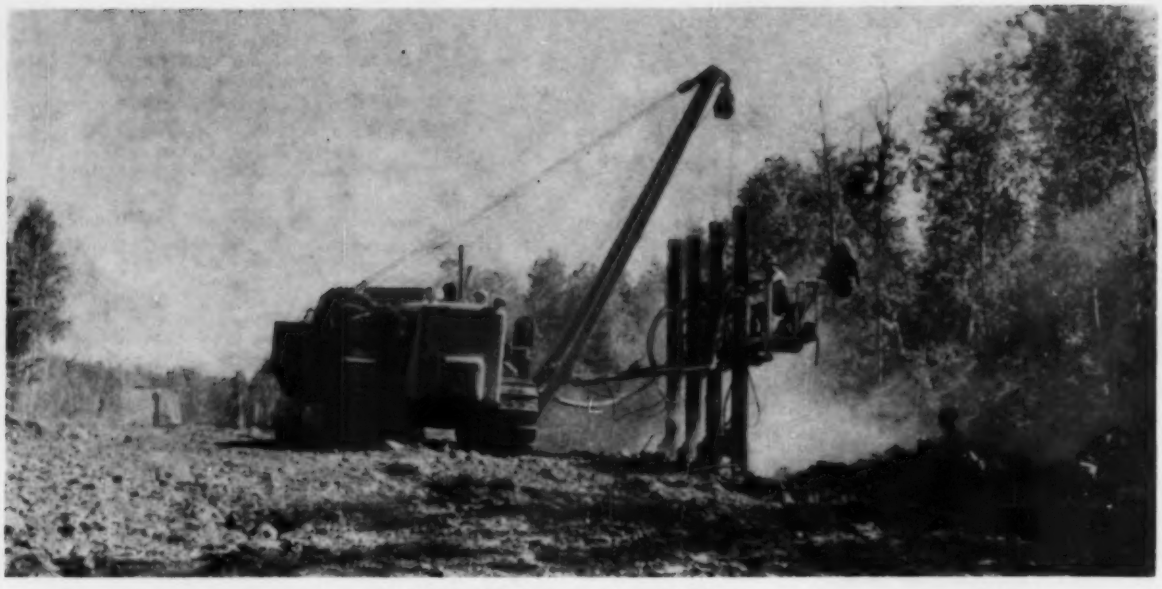
Spread 8 started at the Kapuskasing River east bank, as the river crossing was let separately. It contained 82 miles, terminating in the vicinity of Potter, a small town on the main trans-Canada highway between Cochrane and Kirkland Lake, in the heart of the northeastern Ontario mining country. At the western end there is some shallow muskeg, but the terrain goes through a quick transition into the clay belt, which makes up most of the section, with the occurrence of some glacial till and boulders at the eastern end. This contract was awarded to Grayco Constructors, Ltd.

Spread 9 ran from Potter to a point a few miles south of Kirkland Lake, one of the largest and most famous mining towns in eastern Canada. Its 83 miles are entirely glacial till, with many stray and loose boulders in the clay belt, and there is practically no outcrop rock or even subsurface rock to drill. The job was awarded to Majestic Contractors, Ltd.

Spread 10 took in 57 miles from the point south of Kirkland Lake to a point near Rib Lake, in rather wild recreation area in the granite rock country. It starts in the clay belt, running through some mixed farming country, with alternating high ground and swamps, some muskeg, and a few steep river and creek beds. About half way along it merges into solid granite, and the southern half had to be almost all drilled and shot both for right-of-way grade and ditch. The contract was awarded to Dutton-Williams Brothers, Ltd.

Spread 11 contained 47 miles, in solid granite rock interspersed with water courses and included 19 major water crossings, all of which had to be drilled and shot. It runs from Rib Lake to a point near the resort area of Tilden Lake, and for the most part goes through unsettled and almost untouched wilderness with thick evergreen forest growth. The contract was let to Canadian Bechtel, Ltd.

Spread 12 ran south from Tilden Lake to South River for 62 miles, passing through the same type of wilderness granite rock terrain for the first third of the distance, involving a heavy



Quad rock drill on spread near North Bay.

amount of drilling, then went through patchy rock terrain interspersed with swamps and some clay-type farm land for a short distance, and emerged onto a sandy clay plateau with many steep hills and grades and some swamps of considerable length in the southern half. The job was awarded to Morrison-Shivers, Ltd.

Spread 13 comprised 63 miles, from South River to a point near Bracebridge. It included a mixture of terrains, varying from steep and almost fluid sand hills to tough granite rock outcrops. Most of it was gently to steeply rolling, with the largest proportion of sand hills and glacial till in the northerly half and almost all solid rock in the lake country at the southern end. The contract was awarded to Price-Poole, a joint venture of H. C. Price Co. and Poole Construction Company Ltd.

Spread 14, the longest by a good margin with 92 miles, ran from Bracebridge to the town of Maples, near the north side of Toronto, the junction point at which the eastern section of the main line takes off to Montreal and the lateral to serve the city of Toronto extends off to the south. There is a large concentration of granite rock at the north end, where it is still in the lake country, but this is for only a few miles. There is a quick transition into boulder till and clay, with some swamps, which become more numerous as the south end is approached.

One of the particularly large swamp areas was the crossing of the famous Holland Marsh, about 1½ miles wide, which is the source of almost all the fresh vegetable supply for the whole city of Toronto. The bulk of the terrain is highly cultivated and heavily settled farm country, with numerous fences and other encroachments on the right-of-way. The contract was awarded to Oklahoma Pipeline Constructors, Ltd.

Contracts Let Early

All contracts were let early enough in the winter, and surveys were completed early enough, that every contractor with rock drilling to do was able to get on the right-of-way in the winter, as far as weather permitted. Some winter stringing was also done, in areas where no rock had to be shot. Right-of-way clearing was mostly started in January or February, with rock drilling immediately following it.

In muskeg terrain, a considerable amount of riprap was built up during the winter, the best time to work on it, using mostly timber cut by brushing crews. The riprap, laid to a depth of 4 to 6 ft above the frozen ground, was filled and packed with clay, sand, and gravel, depending on what was available in the immediate area, so that it formed a solid roadbed from which all vehicles and equipment, from stringing trucks to backfillers, could work without sinking in or having to be winched.

Rock drilling, for the most part, proceeded very well on the southern spreads, and some rock gangs were finished with their jobs by the end of June. Practically all rock in these areas had been cleared, both for right-of-way and for ditch, by the end of July, with the exception of odd stringers, which were exposed by backhoe or ditcher stripping close to the bottom of the ditch depth. It was not practical to strip for rock ahead of time, except in terrain where the rock was known to be reasonably continuous, and some unexpected ledges were found at depths of 4 or 5 ft in the course of conventional ditching in a few areas.

Stringing throughout all jobs was complicated and slowed down by stringent Ontario highway department regulations that prohibited Sunday hauling on the roads. This rule was imposed because of genuine traffic hazards caused by the large amount of normal weekend traffic, as the trans-Canada highway, from which all over-the-road stringing had to be done, is the only road through the entire route of the line from the Lakehead to about halfway from North Bay to Toronto. In a few sections, stringing trucks were able to travel on the right-of-way, and in this case there was no Sunday shutdown. Main line work otherwise was on a seven-day week basis, with most crews on a 12-hr day.

On the Price-Poole section, all pipe was double jointed, using the same patented shop-fabricated fully automatic yard that was used on one of the Manitoba sections in the western portion of the line in the summer of 1957. The yard was used with only minor modifications, and operated at an improved production rate compared to last year. The average was 110 welds per day for a daily footage of about 9000 ft, and the last joint was welded before the end of July. The Price-Poole yard also handled most of the pipe for

the early part of the Oklahoma spread, on a custom basis. For the other spreads double jointing was not considered practicable because of the large proportion of rock or muskeg and other terrain problems.

Pipelaying Started in June

Most of the spreads kicked off early in June with pipelaying, and averaged about a mile a day, excluding days shut down. Some remarkable daily footages were achieved for 30-in. pipe, with pipe gangs running as high as 10,000 ft in a top day, using three stringer bead welders and four hot pass men. Dope gang footage ran as high as 7000 ft, and ditchers could make a maximum of 6000 ft in a double shift of 24 hr on straight runs.

Nearly every spread had two ditchers in the regions of good terrain, but the Bechtel section did not have a single yard that could be cut with a rotary ditcher, and most of the other northern sections required a large proportion of backhoe ditch in addition to the conventional rock ditch.

Rock ditch was generally drilled about 44 in. across the ditch and 50 in. along, with the shot holes staggered on opposite sides for an effective spacing of 25 in. A good average footage for one drill was 185 ft a day. Most ditch was shot clean with a single shot of 40 percent dynamite. Drills were of a wide range, twins, triples, and a few quad units, mounted on tractor frames or hung from the sideboom.

River weights have been used in large quantities, for water crossings, swamps, and muskegs. For buried crossings, the split collar type were bolted on. Set-on weights, of the square type with a concave bottom to fit around the upper half of the pipe, were used on all other wet locations. An innovation this season that proved highly satisfactory was the use of powdered iron for aggregate in the reinforced concrete, instead of sand and gravel. This material, readily available in the territory through which the line construction passed, provides much greater weight than regular concrete for the same bulk, gives a more solid mix with less danger of cracking or chipping, and has reduced the number of weights required for any given distance.

Extra protection for the pipe, outside the regular outer wrap was provided for all river-weighted sections and through all rock ditch. The special wrap was an asphalt-impregnated quarter-inch 5 by 8-ft rectangular slab of rockshield, which was attached with thin steel bands under tension, secured by small turnbuckles. In the severe rock sections this rockshield was continuous for several miles at a stretch.

Another precaution for rock ditch areas was ditch padding with sand bags at intervals of about half a pipe joint. Three or four sand bags were laid into the bottom of the ditch at each protection point, and pipe was lowered in on top of them leaving a space of about 5 or 6 in. between the pipe and the bottom of the ditch. No earth or loose sand padding was used, as it was not available in most of the rock ditch areas without excessive cost of hauling it in from a considerable distance.

Double-jointing by fully automatic method in yard near Huntsville.

In backfilling through all rock ditch, specifications provided for the use of lizards or "shedders" such as were used on the Crown line construction in the Kenora district last year. The shedders consist of half-round sections of casing, slightly larger than the pipe diameter. Each one was hung from a sideboom tractor which runs parallel with the backfill bulldozer. As the bulldozer pushes the rock over from the backfill side of the ditch, the loose rock falls onto the shedder. Then as the sideboom tractor moves along the rock is spilled from the back end of the casing onto the rockshielded pipe, a drop of only an inch or two, without enough impact to do damage to the wrap. As a general rule, some of the smaller pieces of rock will land under the pipe, but in most places there will be some open space between the sand bags so that for the most part the bottom of the pipe is resting clear of rock.

Specific details set out hereafter apply only to the five spreads at the southern end of the Trans-Canada section, which is privately owned, as it had not been possible to visit the other spreads at the time of writing.

Spread 10 — Swamps and Rock

On Spread 10, under contract to Dutton-Williams, Jerry Nash was spread superintendent.

Rock ditch on this spread started in mid-March, and 10 twin drills were used until the middle of July, when all rock ditch was completed. Four highway and four railroad crossings were involved, of which two roads and all the railways had to be bored and cased. This contractor did its own stringing exclusively.

Jerry Nash, who originated the use of riprap in Canadian muskeg on the Peace River line in 1955, put in several miles of heavy riprap through the many swamps at the northern end of the section during the winter, with excellent results for vehicle mobility. A few joints of pipe were double jointed on the right-of-way while the pipe gang was waiting for spring road bans to come off, but otherwise all pipe was laid as single joints.

One of the features of the pipe gang was the use of a new type fully automatic pneumatic internal lineup clamp, run from a compressor on the hot pass tractor. Another unusual feature was the splitting of the hot pass into two tractor-mounted units of two machines each for extra flexibility. The four hot-pass welders worked in teams of two, but one team could work separately on short tie-in sections without causing any holdup for the other.

One major river crossing on this sec-

River weights in muskeg near South River.

Dope gang on undulating terrain near South River.

tion, 400 ft across the Montreal River with a maximum depth of 50 ft, was pushed. Otherwise the minor rivers and creeks were ditched with backhoes and the pipe gang walked through them or left a section to be lifted in by the tie-ins. Several big swamps and muskegs were encountered, including one continuous muskeg of three miles in length at the point where the rock terrain blends into the upper farm land.

A large amount of bending was required on this section, because of the rock outcrops in the southern sector and the rolling land, including several deep creek channels, in the northern end. On one day 80 bends were made in 100 joints. The bending gang averaged around 100 bends a day, with a maximum of 180.

As coal tar enamel was used on the section, wrapped pipe was cradled into the ditch from the dope gang catch-off tractor whenever terrain permitted. Through rock country on all spreads the pipe had to be skidded after wrapping, for the rockshield work. In cases where asphalt dope was used the pipe also had to be skidded at all times, because of the slow setting of the enamel, and was lowered in the next morning by the dope gang.

Spread 11 — No Rotary Ditch

Spread 11, under contract to Canadian Bechtel Ltd., had Henry (Hank) Mogg as general superintendent and Mike Finnerty as spread superintendent.

This is the section on which no rotary ditch was cut at all, as the entire terrain is either rock, muskeg, swamp, or water. There were 19 major water crossings altogether, all of which had to be drilled and shot. Some of these were put in through the ice before the spring breakup, but most of them were laid in open water. The most unusual feature was the rigging up of twin drills with platforms for the operators to stand on when they were drilling in shallow to moderate depth water.

Weather was a fairly constant problem, with a great many wet days when the whole spread was rained out except for the rock drills and backhoes. The spread was literally strung out along the whole section for a good part of the time, with rock drills working as far as 25 or 30 miles ahead of the backfill. Tie-ins were frequent, because of rather extreme topography through the rock ledges and swamps. River weights had to be set in swamp and muskeg, with large tractors working in pairs, one to winch the other through the soft ground.

A great deal of the swamp terrain was too fluid even to permit riprapping, and tractors were wallowing up to floor level at times. Tie-in sections tended to be extra long, some as much as 2000 to 3000 ft, and five tractors were used on the tie-in gang most of the time to handle the heavy sections.

Spread 12 — Quad Drills Used

Spread 12, under contract to Morrison-Shivers, Ltd., was directed by E. J. Kretschmar, assistant to the vice president, with John R. Wells as spread superintendent.

One of the outstanding features of this spread was the use of quad drills, one unit of each make, mounted on hydraulic frames on D8 tractors, making it possible to drill both sides of the ditch simultaneously with two holes on each side or four holes at once on one side.

Rivers and creeks occurred on the average of about one per mile, some in rock and some in swamp or muskeg. Swamp accounts for about one-third of the whole section, with rock through about another third. Sand and

stray boulders were a continuous problem for the rotary ditchers, but because of the good solid clay composition of the soil in most of the portion that could be cut with rotary ditchers, the ditch was extended 10 to 15 miles ahead of the pipe. Backhoes were used on rock ditch, including clearing right-of-way after shooting, and clearing out the ditch after the second shooting. The right-of-way gang also had heavy bulldozing equipment to move large rock fragments.

A noticeably efficient operation was the pipe gang, which had two quad units and was able to make as much as 8000 ft on a top day, averaging a mile a day through generally hilly and rolling country.

Tie-ins were frequent because of the swamp and rock, and a great many river weights were set in the muskegs near the south end of the section. The ground was very unstable through these muskegs and swamps, and only a rudimentary riprap could be laid, so there was considerable winching of equipment. Three clamshells were used on the tie-in gang to dig out caved ditch in these areas, and ditch generally had to be pumped out before lowering in.

Spread 13 — Frequent Swamps

On Spread 13, under contract to Price-Poole, Joe Price was special representative for the president and Clarence Shivel spread superintendent.

Frequent swamps occurred on this section in the first 20 miles from the south end, followed by some large and steep sandhills and about 20 miles of rock in patches. Ditching was done with two big ditchers, and running a single shift each they were able to get as far as 20 miles ahead of the pipe gang. Eight backhoes were used to ditch through the swamps and sandhills. One particularly high and steep sandhill required the removal of several thousand yards of sand on a slope close to 30 deg to get right-of-way wide enough to satisfy specifications. Dope pots had to be winched up some of the sandhills.

Some remarkable footages were obtained with the double-jointed pipe, with 8000 ft an average day and some days close to 10,000 ft. The dope gang made 7000 ft on its best day. Tie-ins were held down to an average of two or three to the mile, but heavy equipment was assigned to the tie-in gang for the long swamp sections. One of the larger swamps required 66 set-on river weights on 11-ft centers.

Welding machine wagons were special shop-fabricated models, having four wheels with pneumatic tires, and because of double-jointing the firing line has been held to a limit of eight welders. The pipe gang had one quad unit for the stringer bead, and a tractor-mounted unit for the hot pass.

One of the special features added to the double-jointing yard this season was a new type of beveling machine that uses all ball bearings and no sliding joints on the arms.

Spread 14 — Peat Bogs

Spread 14, under contract to Oklahoma Constructors, Ltd., had Leaman Creech as spread superintendent.

Peat bogs were a severe problem on the southern end of the job, including the large Holland Marsh. In many cases their presence could not be detected from the surface, until the lead tractors bogged down. Distances varied from a few hundred yards to three exceptionally long stretches of 8000 ft, 9000 ft, and 11,000 ft. All had to be river weighted.

A total of about 40 miles of rock was encountered in the northern part, and four sets of twin drills were used in this area. Conventional ditching was managed for more than half the distance.

Extensive riprap through the swamps made fairly easy going for equipment except in wet weather. One of the principal problems was the enormous number of fences in the southern half of the section, where the land traverses some of the most heavily settled and intensively cultivated parts of the southern Ontario farm land. Farm drain tiles were frequent here, because of the limestone ledges a few feet below the surface that hold the runoff water. These had to be cut and replaced carefully wherever they were encountered.

Other ditch problems mainly consisted of caving in soft clay or sand terrain, and a few areas of stray boulders in glacial drift.

Both the pipe gang and dope gang were able to top 9000 ft on their best days, due to the double-jointed pipe, and the whole spread averaged a mile a day apart from down time. Ditchers were used, even in the hilly country where they had to be winched up or down hills occasionally. Tie-ins were frequent, and the tie-in gang has made as many as ten in one day, averaging five or six.

A special feature of the dope gang was the use of two sideboom tractors, a D8 and a MDW 8 with hydraulic controls for the counterweights. Shop-made special convex tracks of extra width were also used on these machines to make it easier for them to walk through soft ground. They are believed to be the first tractors in Canada to employ both modifications.

Because ditch was kept ahead of the pipe all the way, another innovation was employed to save extra work, by having the ditching backhoes fill the riprap roadway with excavated material from the ditch, taking alternate swings to the riprap side and the backfill side.

Five Compressor Stations

Trans-Canada has installed five compressor stations as the first stage in what it is hoped will be a steady expansion program leading ultimately to several dozen stations and then to a selective looping project.

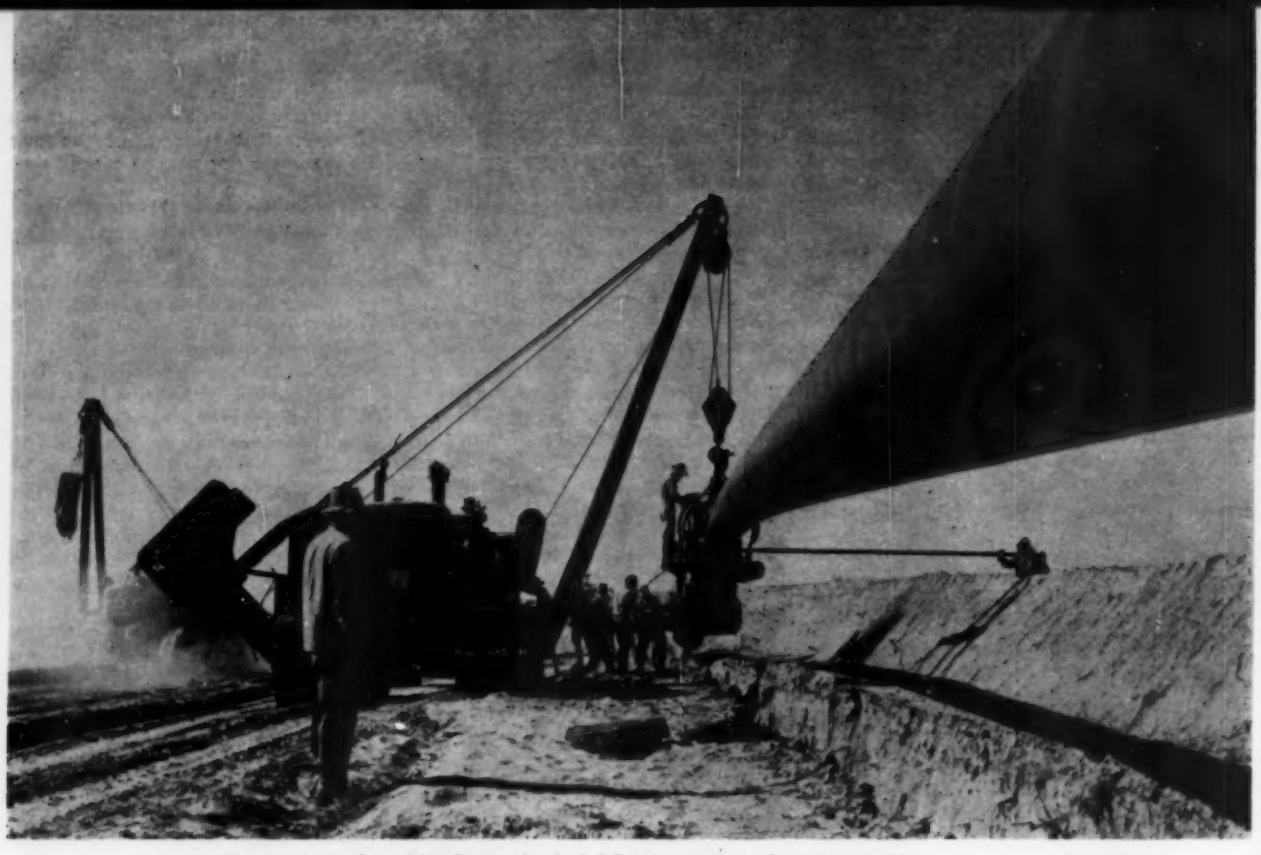
Three large identical stations were constructed at Burstall, Caron, and Moosomin, spaced about equally across Saskatchewan. Each was equipped with three 3400-hp engines for a total of 10,200 hp. As electric power cannot be provided in enough volume by the Saskatchewan Power Corporation, each of these stations has two 250-kw, 312.5 kva at 720 rpm 60-cycle 3 phase gas-engine generating units to provide self-contained power for the compressors, operating on line gas. Each station is designed for eventual expansion to four groups of three compressors or 40,800 hp.

Moving the 92-ton compressor engines onto the sites represented a major job, with the use of specially designed double goose-neck floats. In several places highway or municipal road bridges had to be shored up to carry the weight, and the contractors used 12 by 12 timbers on all bridges to distribute the weight safely. Soft spots on the access roads had to be timbered similarly.

Foundations proved no problem in the prairie country, but piles had to be driven at all stations except Moosomin where a pure blue glacial till clay, practically impervious and with very high bearing strength, was found over the whole site. Here the reinforced concrete slab base for the compressors was simply poured over the excavated trench at 12-ft depth. The slab is 2-ft thick, with the engine mount blocks poured integrally on top of it.

At Ile des Chenes, Manitoba, where the 34-in. line steps down to 30-in. line, 7500 hp were installed, with three 2500 hp engines. Piling was used extensively here because of the terrain, which is a flood plain of the Red River Valley, with yellow clay of poor bearing strength and a tendency to swell in wet weather and contract when it dries out.

At North Bay, Ontario, where the major lateral takes off for Sudbury, there are three 1800 hp units. This station is unique on the whole line, in that it is equipped to send gas in either direction, providing flexibility for the southern end of the line where emergency or peak load demand may require occasionally a northward transmission of borrowed gas from the large southern Ontario utility companies. ★



Pipe was lowered immediately into the ditch following coating and wrapping on Texas-New Mexico Pipe Line Company's new system from Four Corners area to Jal, New Mexico. P 615.51

TWO STATIONS ONLY FOR 512-MILE SYSTEM

In fact, pressure must be reduced on Texas-New Mexico's new line because of wide variations in altitude

Frank H. Love, *Editor*

START OF OPERATIONS recently by Texas-New Mexico Pipe Line Company's system between Aneth, Utah, and Jal, New Mexico, gave the prolific Four Corners area its second pipeline outlet. It also marked the first time Four Corners oil could be shipped to markets in the Gulf Coast, Mid-Continent, and Chicago areas by means of existing pipelines.

Initially the capacity of this 512-mile, 16-in. line is 50,000 bbl a day with two pumping stations, but capacity can be increased by installation of additional pumping stations. Maximum operating pressure is 1000 psi; present pressure approximately 850 psi.

Isolated location of the line, and the great difference in altitude of its originating and terminal points, dictated many of the design and construction considerations. These points stand out:

1. Pressure reducing stations were necessary because of wide variations in altitude.

2. Heavier walled pipe was used where pressures are greatest.

3. Only two stations are required at present capacity, the drop in altitude of approximately 4000 ft making possible utilization of gravity flow for the last 281 miles.

4. Remoteness of right-of-way caused problems in housing and transportation of workmen during construction.

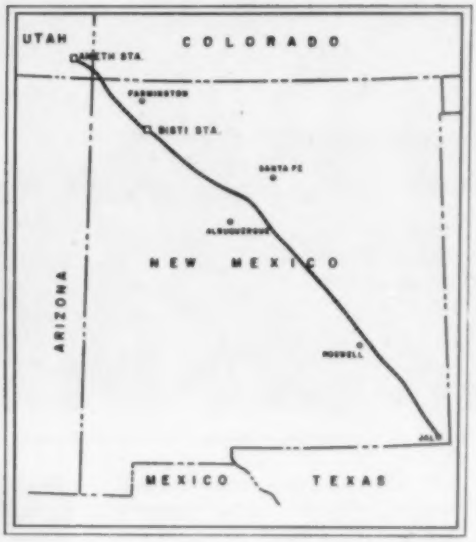
Route of Pipeline

The pipeline system has its origin in the Aneth field of the Paradox Basin. The gathering system that feeds the line had been constructed previously, consisting of 6, 8, and 10-in. line. A 13.5-mile, 4-in. discharge line took the oil to a tank truck loading rack before the new line was built.

From Aneth station, which is at an elevation of 4445 ft, the line extends in a southeast direction, barely slicing off a corner of Colorado before entering New Mexico. Elevation increases gradually until it reaches a maximum of 6995 ft at Milepost 231. From there the grade is downhill to the terminus at Jal, which is at an elevation of 2980 ft.

The severe drop in elevation builds up a static head at Jal of 1400 psi. In

Workmen insert line-up clamp as sideboom tractor is about to pick up another joint of pipe for welding.



Route of Texas-New Mexico line from Aneth to Jal.

view of this, pressure reducing stations were installed at two locations, and heavy wall pipe used where pressures are greatest.

One pressure reducing station is at Mesa (a future pumping station location) and the other at Jal. Mesa is approximately half way between Jal and the highest point on the line. Approximately half of the static pressure is reduced at Mesa, and at Jal it is brought down to a safe suction pressure.

Line Pipe

Approximately 300 miles of the pipe has wall thickness of 5/16-in., and 212 miles ¼-in. wall. The heavier 5/16-in. pipe was placed downstream from the two existing pump stations, as well as downstream from future station locations, in the Rio Grande River Valley, and between Mesa and Jal, to take care of increased pressures at those points.

Pumping Stations

Aneth is the initiating station, the station at Bisti a booster. Each has a single 1100-hp, 8-cylinder, turbocharged dualfuel engine driving a centrifugal 6 by 8 by 12½, 5-stage pump through a speed increaser. Foundations have been poured for second units at each station, however. Bisti station is remotely controlled from Aneth over a wireline. For this reason, and the fact that Aneth also will be the control point for some of the future stations, personnel is in attendance at all times. At Bisti the crew consists of two men, whose functions are principally of a maintenance nature, but they will be available also in case of an emergency.

Aneth and Bisti stations both have pneumatic equipment to control suction and discharge pressures automatically by varying the speed of the engines.

Principal control equipment at Bisti includes a sequence control cabinet and a supervisory control and telemetering system.

Welder strikes an arc as helper cleans slag from previous pass.

Aneth station, originating point of the system. Manifold and booster pump unit are shown. Latter is an internal-combustion engine connected to a centrifugal pump, which takes suction from the manifold to keep the intake of station's main pumping units flooded, and also is used to draw down storage tanks.

Bisti station is remotely controlled from Aneth. Pumping equipment is the same as at Aneth.

At both stations automatic equipment is provided to give protection against these possibilities: (1) Low station suction, (2) high station discharge, (3) engine overspeed, (4) low engine lube pressure, (5) high engine jacket water temperature, (6) pump seal leak, (7) excessive engine vibration, (8) excessive station sump level, (9) excessive pump room sump level, (10) loss of pump room ventilation, (11) high pump bearing temperature, and (12) high gear bearing temperature.

Occurrence of any of these conditions will cause the pumping units to be shut down.

At both stations, also, a 62.5-kva engine-generator set provides power to actuate the motor-operated valves, drive the air compressor, and light station buildings and cottages.

A low-pressure boiler provides hot water to heat the stations and warm the engine jacket water prior to start-up.

Jacket water is cooled in a shell-and-tube type heat exchanger that transfers heat to the crude oil stream.

Aneth, Bisti, Mesa, and Jal are locations for launching and receiving scraper traps. Necessary power to control the valves in the scraper traps is available at all points except Mesa, which is a remote location. Here, the 16-in. valves in the scraper traps are equipped with piston operators, which are actuated by a pump powered by a hydraulic motor that is driven by crude oil in the main line. At this location main line pressure also is utilized to drive the compressor that provides air to operate the pressure reducing valve.

Each station also has a 1000-bbl fuel tank, and at Aneth there are three 80,000-bbl crude oil receiving tanks.

Interior of pump room at Aneth station. A 1100-hp, 8-cylinder, turbocharged dualfuel engine drives a 5-stage centrifugal pump through a speed increaser.

Construction Highlights

The Aneth field, starting point of the new pipeline, is on the Navajo Indian Reservation in southeastern Utah. This is isolated and rough country for the most part. Approximately 25 percent of the entire right-of-way is in rock (actually 129 miles). This, of course, required an exceptional amount of blasting, but probably the most troublesome aspect was housing workmen and supervisors. Housing facilities simply did not exist previous to the start of this project. Consequently, some contractors established camps, some workmen brought trailers, and some were flown to the job daily from Farmington, New Mexico.

Three rivers were crossed, the San Juan, Rio Grande, and Pecos, but none was a wide crossing and single lines were laid beneath the river beds by conventional methods.

The line was tested hydrostatically, and because of the vast difference in elevations, it had to be done in 16 sections.

Design work for the line and the two initial stations was performed by Texas-New Mexico Pipe Line Company's engineering staff in Houston.

Panama, Inc., Houston, Texas, and Four Way Company, Aztec, New Mexico, were contractors for line construction. Station Construction Company, Houston, contracted the stations.

Overall supervision of operations is from the Division Office at Midland, Texas, with district maintenance personnel making headquarters at Blanding, Utah, and Eunice, New Mexico.

* * *

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Pipeline Fundamentals

Interior view of a central dispatching office. The revolving cabinet, in center background, is a unique arrangement that makes it possible for the dispatchers to have easier access to the teletype machines. When a message is being transmitted, this setup also eliminates some of the noise from the adjoining teletype room.

Function of the Gas Dispatching Department

H. B. Lafferty,
Chief Dispatcher
El Paso Natural Gas Company
El Paso, Texas

Gas dispatching has been defined as "the directing of the flow of gas from its source of production to its point of usage in sufficient quantity and at a satisfactory pressure and quality, at all times, regardless of conditions."

So important is the function carried out by this department that it has been called the "nerve center" of a pipeline system's operation.

All matters pertaining to, or in any way concerning, the movement of gas are cleared through the dispatcher's office, including such matters as the scheduling of repairs to pipelines or other facilities.

Due to the wide variation in the nature of its operations, the gas industry requires various techniques in directing the movement of its product. The range of these techniques is so wide that gas dispatching is normally divided into three classifications: (1) Long lines, (2) Network, and (3) Distribution.

This article will be concerned only with the fundamentals of gas dispatching as employed in the operation of a long distance pipeline transmission system.

Basically, long lines dispatching consists of collecting gas from numerous natural gas producers and directing its flow

through hundreds of miles of single or parallel pipelines to distribution systems and large industrial customers.

In directing the flow of gas through the intricate pipeline network that comprises a long distance transmission system, all operations are coordinated to function as a unit. All activities fit into an intricate pattern. Within the framework of this pattern lies a multitude of details, which makes the job of mainline dispatching a complex one.

The variables a dispatching department must solve are almost without end. The market for gas shifts and changes. Sources of gas fluctuate widely from month to month. One of the biggest variables of all is the pipeline system itself. From hour to hour, certain sections of pipeline are taken out of service for overhaul or are put back into service; an engine fails at a compressor station; possibly an entire station goes off the line unexpectedly.

A dispatching department must know all of these changes as they happen and adjust operations elsewhere in the system to meet the new conditions.

The primary function of a gas dispatching department, as pointed out, is determining the market demand for gas and adjusting the operations of a pipeline system to meet those demands. In fulfilling this task, a dispatching department is responsible for controlling many other diverse activities affecting the operation of the system, which will be discussed later.

DETERMINING MARKET DEMAND

A mainline dispatching department maintains a constant study of market conditions and places "orders" for specific quantities of gas with the various field division dispatchers in areas from which supplies are drawn.

One of the biggest variables in the market demand for gas is, of course, the weather. All in all, the demand for gas varies according to weather conditions, being determined by such things as whether the temperature is hot, cold, or moderate, whether the air is still or windy, whether the atmosphere is dry or humid, and other factors.

In order to anticipate as nearly as possible the demand for gas as it will be affected by the weather, a dispatching department receives weather reports constantly.

Regular government forecasts are adequate for many companies; others employ the services of commercial forecaster. Some companies also maintain their own meteorologists within their gas dispatching departments. To keep further abreast of the weather, many gas dispatching departments check conditions periodically each day at various locations along the system.

Various services are available to aid in forecasting the weather. One such service, for example, supplies a summary of existing weather conditions from points throughout the United States and parts of Canada by teletype every hour.

Still another service supplies pertinent weather data by teletype every six hours including each state's forecast, its maximum and minimum temperatures, and other information.

Another source of weather information is a facsimile service, operated by the U. S. Air Force in cooperation with the Weather Bureau, which supplies forecasts in the form of weather maps.

Some of the maps so provided are not used by a dispatching department. For example, one map gives wind conditions in the stratosphere. Several of the daily maps, however, are very useful. One shows weather conditions throughout the United States as they are at the time the map is transmitted. A second is a forecast of what weather conditions will be in 30 hours. Twice a week maps are sent out that give a five-day forecast.

Weather forecast maps received by a dispatching department enable it, in a general way, to determine what the demands for gas will be. It is not possible to anticipate with pin-point accuracy, however, how much gas will be used. This is because there are too many variables.

Consumption of gas depends not only on the temperature but also upon such things as the direction and velocity of the wind (high winds tend to push cold air into homes and to increase gas consumption), and the humidity (cold wet air feels colder than dry air and, therefore, the greater the humidity, the greater the consumption of gas.)

Even with all these variables, however, a dispatching department is able to determine each day within, say, 10 to 15 percent accuracy, what the demand for gas will be for the next several days and basic plans can be made.

The department needs to know almost exactly what gas sales will be for the 24-hr period immediately ahead, however, and weather forecasts do not provide sufficient accuracy for purposes of this close estimating. Accordingly, certain mainline dispatching departments have developed

Pressure readings from different points along a pipeline system are received constantly on telemeters such as the ones shown in this central dispatching office. Pressure readings also are received by telephone from various compressor stations. The man in the right foreground is taking a report by telephone from an outlying station.

a system of predicting with high accuracy sales for the day immediately ahead.

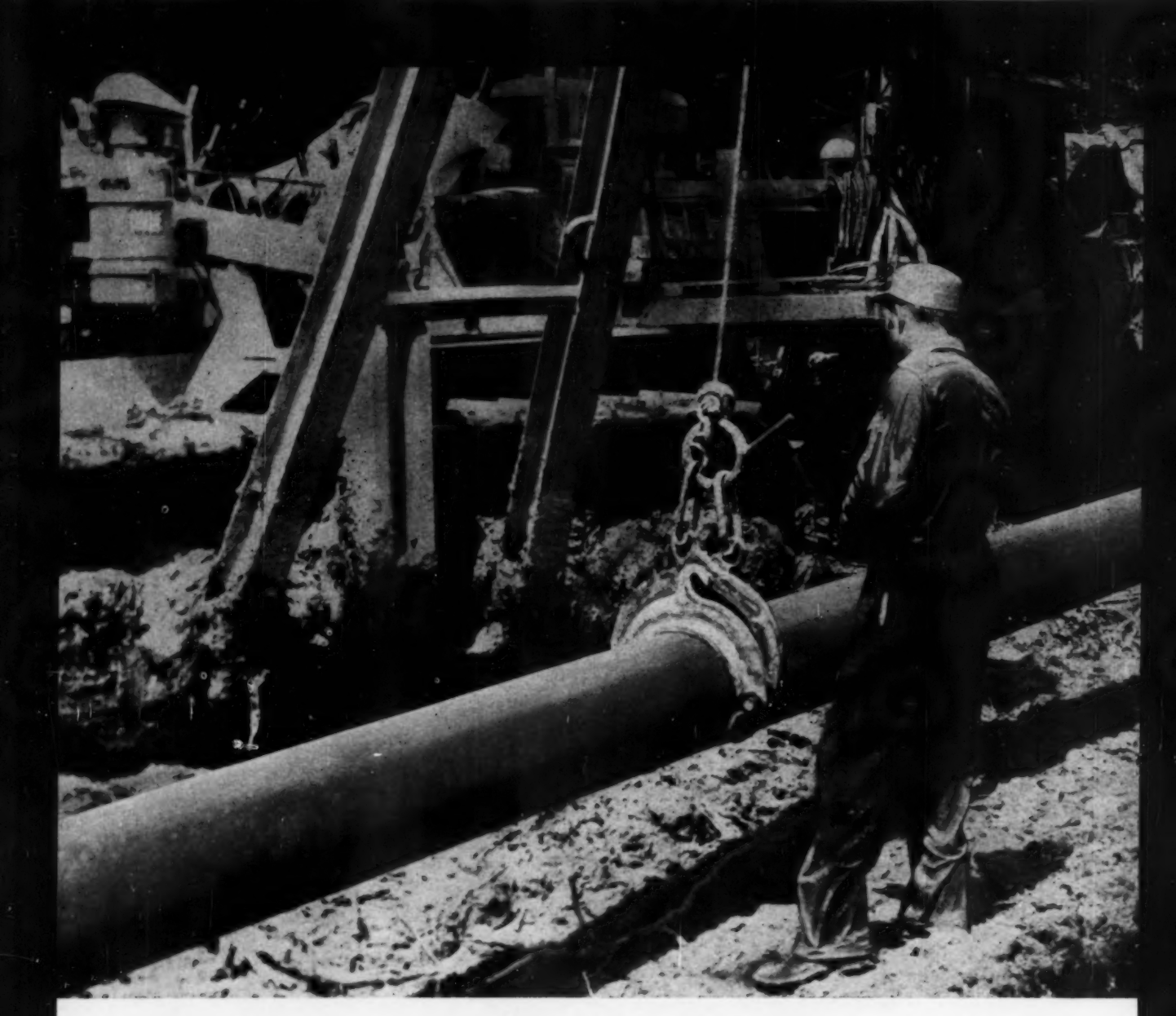
In certain key cities served by a long distance transmission system, mainline dispatching personnel make hourly checks of the volumes of gas being delivered. This is accomplished by examination of the meters in operation at these cities. From past experience, dispatchers know the relationship of volumes of gas delivered during certain hours to the volumes of gas that will be delivered in the periods to follow.

By taking the volumes of gas delivered between 2 and 6 a.m., for example, dispatchers can estimate quite closely how much will be delivered between 6 and 10 a.m. or how much will be delivered between 2 and 6 p.m., or how much will be delivered in any other specific period in the full 24 hours. Thus, from information developed hour to hour, dispatchers can predict demand for a day ahead of time in these key cities.

These key cities also have a certain relationship to other communities and areas served by a company. When a 24-hr forecast is developed for these key cities, various indices are then applied to determine how much gas will be needed elsewhere in the area served by a pipeline company.

MEETING THE DEMAND FOR GAS

As soon as the demand for gas is determined, mainline



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	SIZES (in., OD)	WALL THICKNESSES (in.)	LENGTHS	SPECIFICATIONS
HYDRAULICALLY EXPANDED ELECTRIC FUSION-WELD (submerged arc)	22 and 24 26 through 36 36 through 42	¼ to .438 incl. ¼ to ⅝ incl. ¼ to ¾ incl.	40-ft ①	API 5LX, Grades X42, X46, X52 & X56
ELECTRIC RESISTANCE-WELD	5 (nom) to 16	API	to 60-ft	API 5L, Grades A & B API 5LX, Grades X42 & X46
CONTINUOUS BUTT-WELD	½ to 4 (nom)	API	SRL 24 to 26-ft DRL to 50-ft	API 5L
COMPRESSOR STATION PIPE in diameters, thicknesses, and lengths as required.				
① Expanded after two 20-ft lengths are joined with girth weld.				

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BETHLEHEM STEEL

BETHLEHEM STEEL

In the right foreground, a dispatcher uses a teletype to transmit a report on the weather to offices and plants along the pipeline. Teletype machines are invaluable in dispatching, enabling operators to keep in constant touch with any given point on a system. In the background, an operator reads a weather report just received from the U. S. Weather Bureau.

dispatchers place "orders" for specific quantities with the various field division dispatchers in areas from which supplies are drawn.

There is a constant shifting and changing of production of gas in the various fields in a division. Dispatchers are on duty 24 hours a day to keep the flow of gas into the lines at a level that meets market demands.

In all producing areas, dispatchers are responsible for prorating production among the various dry gas wells that are tied into a company's system. Most of these wells usually belong to other firms, other than the pipeline company that delivers the product to market, thus a pipeline company must take given quantities of gas from each specific well in a month's time.

Field dispatchers must not only decide how much gas needs to be drawn from formation gas wells but must shift the load from one well to another so that the company's contracts will be met.

In addition to supplies taken from formation gas wells, many companies now use a tremendous amount of residue gas, or gas that is a by-product of oil production. Many companies also have supplies of gas stored in underground reservoirs, which they can call upon during peak demands.

The rate at which residue gas is produced is subject to tremendous fluctuations—seasonal, monthly, weekly, daily, and hourly. Toward the end of the month, for example, as producers achieve their oil allowables set by state regulatory agencies, many wells are closed in and the flow of gas from the oil wells is stopped.

On days when a number of oil wells are closed in or on peak winter days, or in certain hours of the night, the supplies of residue gas are far from sufficient to meet the market demands for gas and field dispatchers must supplement receipts of residue gas by drawing upon dry well gas that is taken from underground storage reservoirs.

Field dispatchers receive a constant flow of information by telephone or by telemetering on the quantities of residue gas that is being delivered into the lines. This quantity is measured against the volumes requested by the mainline dispatchers.

If supplies of residue gas are insufficient to meet market demands, field dispatchers then telephone the proper plants and radio gas switchers in the field giving instruction on activity needed.

Thus, if a gasoline plant of an oil company halts production and its deliveries of gas stop, within minutes switchers are turning on gas wells—possibly hundreds of miles away from the plant—to meet the need for more dry gas.

SHIFTING GAS DELIVERIES

As the needs for gas are determined, operations are adjusted to meet these needs. By adding or taking off engines, it is possible to vary the flow of gas through the lines somewhat. But the objective of dispatching is to keep deliveries through the line as stable as possible rather than varying them up and down. The greatest adjustment in operations is made, therefore, not so much by changing the rate at which gas is delivered as by shifting gas from one customer to another.

This policy is followed because idle capacity is expensive capacity. If a pipeline were to be built to serve only space heating requirements, that line would be very active in cold winter months but would be practically, if not entirely, idle during the summer months.

Cost of maintaining such a line and its plant facilities and of amortizing certain fixed expenses against it (such as the real estate taxes, the various administrative costs, and other expenses that are constant) would be just as great when the line was idle as when it was full. Thus, the gas carried in a few active months would have to bear the total expense of the line for a full year. The cost chargeable to each foot of gas delivered would become tremendously high. The more gas that is carried through a line, the more economical is each unit of gas delivered.

By agreements worked out with industrial customers, companies are able to switch pipeline capacity normally dedicated to industrial consumers to the service of domestic (home) consumers on cold days. In summertime, when demands for gas to heat homes is almost non-existent, industrial demands for gas are met 100 percent.

As weather gets cold, certain industrial customers are taken off gas and put on fuel oil (the large user of gas can keep duplicate equipment available so that the switch from one fuel to another can be readily made; the small home owner cannot afford such duplicate equipment). If the weather is only slightly cold, deliveries to industry may be only slightly curtailed; if the weather is extremely cold, deliveries to industry may be curtailed almost altogether.

By studying weather reports and determining, ahead of time, the need for shifting gas deliveries from industrial consumers to domestic consumers, mainline dispatchers are able to give proper notice—several hours or possibly several days— to the industrial consumers of the need to shift to fuel oil for a certain period of time.

Then, as warm weather approaches, notice is given to these industries so that burners can be put back on gas.

The result of this cooperation among industrial consumers of natural gas results not only in substantial economics for home owners but for industries themselves.

The effect of a cold spell on gas deliveries depends not only upon how cold the weather gets but upon how long it stays cold. This is because dispatchers know how to work against "pack," the gas stored in the pipeline. Normally, the "pack" or storage in a long distance pipeline amounts to about a two-day supply.

There is a variation of gas consumption from one day of the week to the next. On Sundays and holidays, for example, most industries are not in operation and use only small quantities of gas. There is, therefore, a certain amount of idle transmission capacity generally available on Sundays and holidays. Dispatching department frequently uses this capacity to increase the amount of gas packed into the line and thus has more gas available in the weekdays to follow.

CONTROLLING A PIPELINE'S OPERATION

A dispatching department must keep abreast of conditions along a long distance transmission system at all times to maintain a constant flow of gas and to make sure it is operating at top efficiency. Any irregularity that interrupts the normal operation of the system must be carefully watched.

Suppose, for example, that an overload develops in the generating room of a compressor station. This could occur from a short circuit, from the breakdown of a particular engine powering a generator, or from many other things that cannot be anticipated or prevented. As soon as the overload is felt, a circuit breaker stops generators and the entire station goes off the line automatically. This is necessary to prevent serious damage to equipment, possibly even a fire.

Skilled men at the station usually can locate the cause of the shutdown, correct it within a few minutes, and put the station back on the line. Getting engines started and back into operation, one at a time, takes 30 minutes to an hour at a minimum, however, and the power of the station is not felt during this length of time.

As soon as a station goes off the line, the suction (incoming) pressure begins to climb and the gas in the line begins to "back up" toward the compressor station immediately upstream. Simultaneously, the discharge (outgoing) pressure of the shutdown station begins to fall and a decreased volume of gas moves toward the station immediately downstream from the shutdown station.

Automatic equipment at a station shuts the station down if the discharge pressure climbs too high or if the suction pressure falls too low.

Thus, unless there was proper warning to, and corrective action by, the stations immediately upstream and downstream, the effect of the shutdown station would be to cause the stations next to it to go off the line. Shutdown of these stations, in turn, would cause the stations next to them to shut down. The net result would be a ripple of shutdowns moving along the pipeline, each station being affected by a second station and passing that effect on to a third station.

The dispatching department is kept constantly informed on conditions along the pipelines and if a station shuts down or something else occurs that will affect the rest of the system, dispatchers provide instructions to the other plants and offices so that the trouble will be isolated and affect only the single plant or section of the pipeline. A shutdown of a station calls for reduced power at the stations just ahead of it and just behind it. These stations continue to operate at a reduced power until the shutdown station can be put back on the line.

PRESSURES MUST BE CLOSELY CHECKED

Dispatchers must know pressure conditions along the lines at all times. Accordingly, every two hours on the even hour compressor stations and certain transmission offices send pressure reports into dispatching. Dispatchers put these data in place, interpret them, and send instructions out on any changes that need to be made. If pressures are going up or down too fast in a particular secton of pipeline, then the stations concerned are told to increase or decrease discharge pressures as the case may be.

Most of the information passing among compressor stations and to dispatching departments is by teletype; however, telephone communications are used in many instances.

CONTROLLING MAINTENANCE, CONSTRUCTION PROJECTS

Dispatching departments also play a key role in major maintenance and construction projects. Take, for example, the matter of tying-in a new line or a new plant. Making a tie-in generally involves several hours of time, and during this interval operations must be severely curtailed, sometimes entirely stopped.

H. B. Lafferty *is chief dispatcher for El Paso Natural Gas Company, El Paso, Texas. He joined the company in 1939 as a timekeeper at Jal, New Mexico, and began his career in dispatching in April 1939 when he was transferred to Phoenix, Arizona. He was transferred back to El Paso in October 1939 as a dispatcher and has remained there since, except during periods of pipeline construction when he worked as a timekeeper and cost accountant.*

Lafferty was named chief dispatcher for El Paso Natural in 1949.

A native Texan, he was born and reared at Hillsboro, and attended Abilene Christian College at Abilene, majoring in education. He received a BS degree in education in 1934. Prior to joining El Paso Natural, he served as a high school science teacher.

Reduced deliveries of gas resulting from the shutdown would be very inconvenient if made at a time when demand for gas was unusually high. Dispatchers, therefore, examine weather reports and provide data on what days shutdowns can be made for overhauls or for the addition of new facilities. If a cold spell is foreseen, a shutdown, in most cases, is postponed.

Frequently, a dispatching department coordinates certain shutdowns so that all of them are made simultaneously. In other words, if mainline stations need certain overhauls made, if a new line is to be tied in, and if work is to be done on certain plants in the field, it is better to do all of these jobs at the same time with only one shutdown than to do them one at a time, over a period of days, with the necessity of several shutdowns.

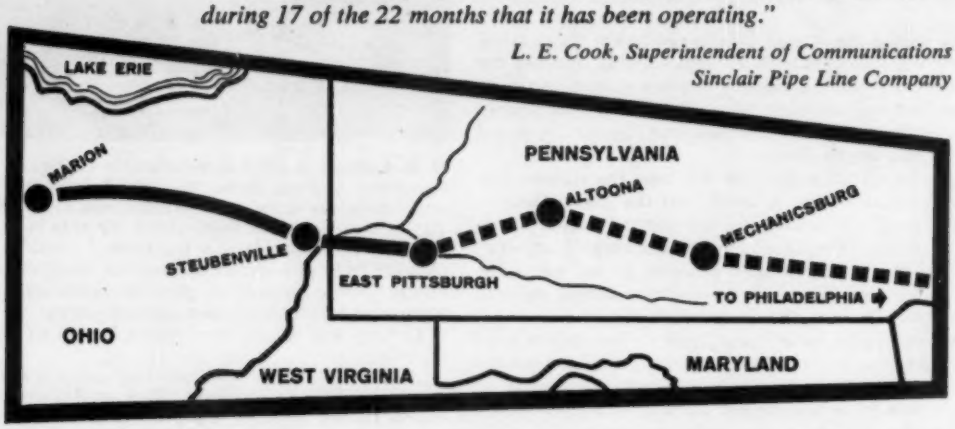
Shutdowns are coordinated with those of distributors. The dispatching department provides advance information to the departments of the distributors that are concerned and these departments, in turn, plan their schedules so that the shutdown can be used for overhauls or tie-ins.

Certain types of heavy construction work cannot be accomplished in bad weather. High winds, for example, make it difficult and dangerous to try to put a long pipe section into place or to raise a contactor. If a construction crew were to move equipment to a certain location to accomplish a particular task and then be unable to finish the job because of a prolonged windstorm, or some other type of storm, the idle equipment would represent delays in construction elsewhere. These crews, in planning certain jobs, must know what the weather will be. Will it be clear? Cold? Rainy? Windy? A dispatching department must provide the answers.

Kellogg Microwave performs at 99.998% reliability!

"...this system has performed exceptionally well...100% continuity during 17 of the 22 months that it has been operating."

L. E. Cook, Superintendent of Communications
Sinclair Pipe Line Company



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Sinclair's dual path system was inaugurated on October 13, 1956. The present system stretches 200 miles from Marion, Ohio, to East Pittsburgh, Pennsylvania. It features 8 channels, 2 terminal stations, and 7 repeaters. All intermediate stations have drop equipment. At East Pittsburgh, circuits are joined by similar Kellogg 10C PTM systems extending eastward to Mechanicsburg then to Philadelphia.

Sinclair's dual path operation between East Pittsburgh and Marion, Ohio has many advantages over conventional systems, principally the elimination of all switch-over equipments or circuits. A failure of one of the units will not interrupt traffic, hence there is no traffic time loss as a result of switching to standby. There is increased reliability since both operating units are continuously monitored for condition of operation. Space or frequency diversity equipments may be operated with a minimum of additional components. In addition to this high degree of reliability and continuous performance, Sinclair reports that "the signal-to-noise measurements have exceeded the original calculations and the system has provided excellent performance since the inaugural date of operation."

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5 Economical system design: drop and insert channels may extend only throughout those parts of the system where required, and not the entire length.

6 Maximum transmitter tube life; tube life averages approximately 15,000 hours for 2C39s.

7 All PTM channels are interchangeable, only one spare is required.

8 High signal-to-noise ratio: the inherent noise of each channel is "clipped" out. Each terminal and each repeater station transmits a fresh signal.

9 Less tower rigidity required for accurate signal transmission at 2000 mc.

10 Plug-in channel units feature printed circuitry replacing tubes with crystal diodes; demodulators semi-passive, one tube per channel; modulators passive, no tubes. Results in 4:1 reduction in the number of tubes and 5:1 reduction in power consumption.

Investigate these and other advantages of a Kellogg PTM Microwave system. Write for complete details.

Pipeline Projects

Early Hearing On Northern Natural $15 Million Request

An early November date has been set for hearing on two applications by Northern Natural Gas Company, asking to construct facilities costing $15,956,500.

Proposed are 103.7 miles of 30-in. main line loops; 18 miles of 20-in. line; 3.5 miles of 10-in. branch line loops; 14,000 compressor hp, and a measuring station. These facilities would be in Kansas, Nebraska, and Iowa.

United Files for Work Totaling $3,000,000

A "budget-type" application by United Gas Pipe Line Company, seeking authorization for the construction of facilities during 1959 at a cost of about $3,000,000, has been accepted for filing, the Federal Power Commission announces.

United proposes to construct from time to time during the year facilities to enable it to take into its main line system natural gas purchased from producers in the general area of its system. The cost of any one connection would not exceed $400,000 and the total cost of all such construction would not exceed $3,000,000.

Pacific Northwest to Lay Loop Line in Wyoming

Pacific Northwest Pipeline Corporation has been authorized by the Federal Power Commission to construct 51.3 miles of 30-in. pipeline in Lincoln and Sublette counties, Wyoming. The line will loop the company's existing 16-in. Big Piney lateral and will enable Pacific Northwest to receive gas from independent producers in the Big Piney and Tip Top-Hog Back fields.

Cost of the project is given as $5,542,000.

Pacific Lighting Gets Permit For 128-Mile, 34-in. Line

California Public Utilities Commission has given approval to construction by Pacific Lighting Gas Supply Company of a 128-mile, 34-in. pipeline to bring an additional 300,000,000 cu ft of gas a day to southern California.

The commission's decision was as asked by PLGS during five days of public hearings. It approves construction of the company's $18,600,000 project subject to the Federal Power Commission's granting a certificate of public convenience and necessity to Transwestern Pipeline Company of Houston, Texas.

The contract with Transwestern Pipeline Company calls for the additional initial 300,000,000 cu ft a day, to be delivered to the Pacific Lighting Gas Supply Company at the California border, near Needles, beginning in November 1959.

Hearings before the FPC on a certificate authorizing the Transwestern portion of the new gas supply project have not yet been scheduled but are expected to be held in the near future.

Pacific Lighting's engineering and construction departments already have made preliminary plans for construction of the 128-mile portion of the projected line.

FPC Approves Request of Manufacturers Light

The Federal Power Commission has authorized The Maunfacturers Light and Heat Company to construct and operate about 34 miles of 20-in. pipeline and a regulating station, at a cost of about $3,047,000, in Greene, Adams, and York counties, Pennsylvania.

The additional facilities will be used to meet the increased requirements of existing customers in eastern Pennsylvania and New York during the 1958-59 winter. FPC in June granted the company temporary authorization to construct and operate the facilities.

Mississippi River Fuel Would Take Ark-La Gas

An application by Mississippi River Fuel Corporation, seeking authorization for the construction and operation of natural gas pipeline facilities, at an estimated cost of about $3,655,400, has been accepted for filing, the Federal Power Commission announces.

Mississippi River Fuel proposes to construct approximately 36.8 miles of 26-in. transmission line; about 3.8 miles of 10-in. lateral line, and a 1320-hp compressor station at Minden, Webster Parish, Louisiana. The additional facilities would enable Mississippi River Fuel to receive natural gas from Arkansas Louisiana Gas Company at the latter's Ruston gasoline plant in Lincoln Parish, Louisiana.

An application by Arkansas Louisiana, seeking authorization for the construction of a 1320-hp compressor and meter station to sell 35,000,000 cu ft of natural gas daily to Mississippi River Fuel, was also accepted for filing.

Another Part of El Paso's Program is Approved

The Federal Power Commission has granted El Paso Natural Gas Company authority to construct and operate an additional 20,400 hp and dehydration facilities at its Aneth field compressor station.

The additional facilities, estimated to cost about $5,500,000, is part of a proposed expansion program to enable El Paso to acquire natural gas from the Aneth field area of Utah, Colorado, New Mexico, and Arizona. El Paso proposes to construct approximately 76 miles of transmission lines; about 102 miles of field lines; a 30,600 hp compressor station; gasoline, fractionating, and dehydration plants; wells for its own production and various appurtenant facilities. The cost of the entire project is estimated at about $26,085,000.

FPC, in August, granted El Paso temporary authority to construct and operate the transmission pipeline and an initial 10,200 hp in the compressor station. The cost of these facilities was estimated at approximately $14,043,000. The remaining unauthorized facilities proposed by El Paso consist of a gasoline extraction plant estimated to cost $6,542,000.

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Transco Given Temporary Authority for Short Line

The Federal Power Commission has granted Transcontinental Gas Pipe Line Corporation, temporary authorization to construct and operate about 15.15 miles of 36-in. main line loops, at a cost of approximately $2,370,000.

The additional facilities would increase Transco's main line capacity by about 25,000,000 cu ft per day. Transco proposes to use this capacity to provide a transportation service for Virginia Electric Power Company, of Richmond, Virginia, and a peaking service to Atlantic Seaboard Corporation, of Charleston, West Virginia. An FPC presiding examiner approved the transportation service but denied the peaking service. The examiner's decision is under commission review.

Texas Gas Files a $20,169,638 Program

Texas Gas Transmission Corporation has filed an application with the Federal Power Commission to construct 126 miles of various diameter loops, install an additional 9040 hp in existing compressor stations, build a new 1800-hp station, and add certain miscellaneous equipment to existing stations. The facilities would be in Louisiana, Arkansas, Mississippi, Kentucky, Indiana, Illinois, and Tennessee.

Texas Gas also proposes to expand existing storage facilities at Oaktown and Alford fields in Indiana and the Dixie and Hickory School fields in Kentucky. This work would consist principally of reconditioning storage wells and enlarging the gathering system.

Estimated costs of these projects is $20,169,638.

Mid-Continent to Albany Pipeline Said Certain

Alfred E. Perlman, president of the New York Central Railroad, is authority for the statement that his company plans to construct a pipeline from Oklahoma and Texas to Albany, New York. The announcement was contained in a speech made before the New York Society of Security Analysts.

A feasibility study has been completed, Perlman said, and "we are now negotiating throughput agreements with oil companies."

The pipeline would be built on the New York Central's right-of-way from St. Louis to Albany. As Central's tracks do not extend farther south than St. Louis, another railroad probably would be involved in the project to provide the southern link of the line. It is rumored that this may be the Katy.

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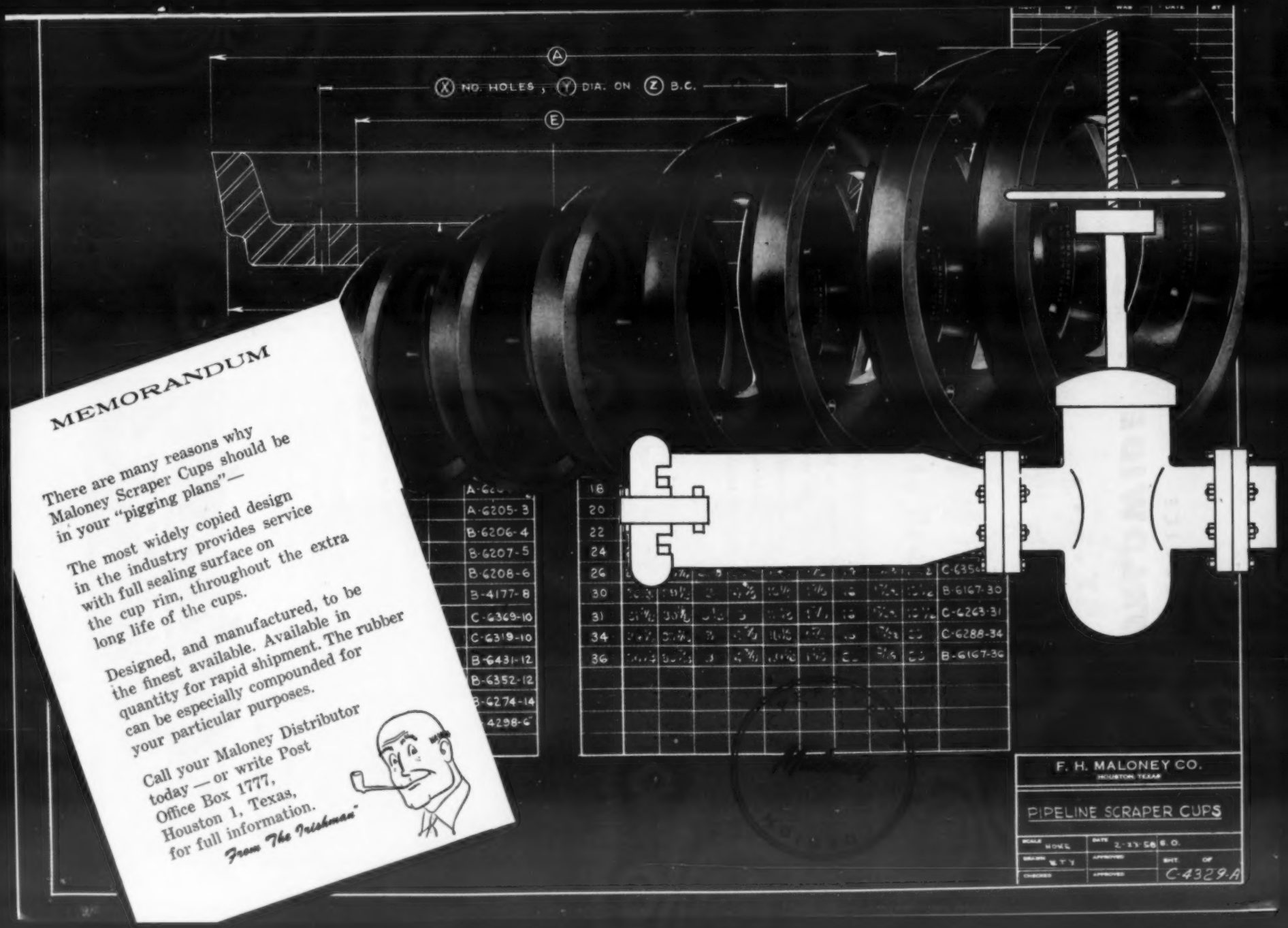
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Projects

Budget-Type Application Filed By Northern Natural

A "budget-type" application by Northern Natural Gas Company for authority to construct and operate natural gas facilities at a total cost not in excess of $4,000,000, has been accepted for filing, the Federal Power Commission announces.

Northern proposes to construct the facilities to enable it to take into its system, from time to time during the calendar year 1959, volumes of natural gas that may become available from numerous small producing areas adjacent to its system in Texas, Oklahoma, and Kansas.

Mich-Wis to Construct Loop Line in Wisconsin

Michigan Wisconsin Pipe Line Company has reserved permission to construct approximately 25.3 miles of 12¾-in. loop line to its Madison, Wisconsin, lateral and to install one 1200-hp compressor unit at its proposed Wisconsin "B" station. Cost of the proposed construction is about $1,433,000. The facilities are part of a $22,000,000 project designed to increase Michigan Wisconsin's system capacity by about 40,000,000 cu ft daily.

2000-Mile Crude Line Announced by Russians

The Soviet Union has announced plans for a 2000-mile crude oil line from Baku via the Ukraine and Poland to the Oder River, with a branch to Czechoslovakia. According to the announcement, the line will transport 4,800,000 tons of oil annually. A refinery will be constructed at the terminus of the line.

Cities Service Gets Permit For Kansas-Oklahoma Work

Cities Service Gas Company has been given a permit by the Federal Power Commission to lay 105.6 miles of various diameter pipelines in Montgomery, Allen, Anderson, Franklin, Miami, Johnson, and Wilson counties, Kansas, to add 3600 hp to its Blackwell, Oklahoma, compressor station, and to develop the Elk City storage field in Montgomery County. Cost of these projects are estimated at $9,786,873.

FPC also authorized Cities Service to abandon and reclaim about 185 miles of varying diameter pipeline between its Grabham compressor station in Montgomery County and Kansas City, Missouri, and to abandon service to The Gas Service Company of Kansas City, for resale to 72 domestic tap customers located on the lines to be abandoned.

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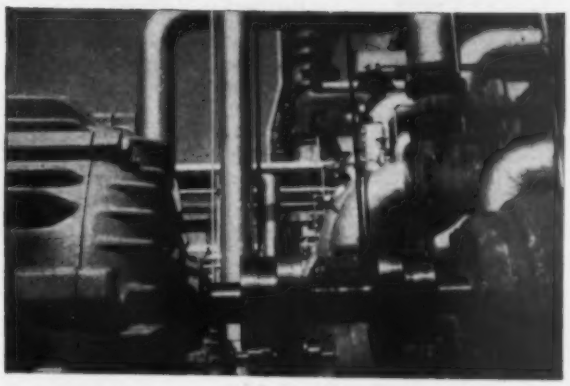
In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 3207 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.

This Fast's Coupling drives a pump delivering heavy naptha to the Solutizing plant.

Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

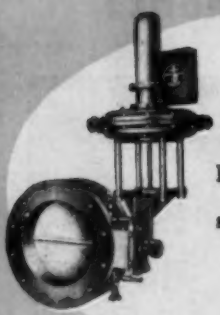
Needle Valves

Rugged, outstanding performers for proportional control of small flows. Interchangeable seat rings and plugs. For water, gas, steam, chemicals. Trim and body materials available for "difficult" fluids. Shown here with unique *reversible* Stabilflo Motor.

GET THE BEST

Saunders Type Valves

A complete line, particularly suited to handling of highly corrosive fluids, or fluids containing solids in suspension. Available with Stabilflo Motor as shown, or with Stabiload Cylinder and Power Positioner.

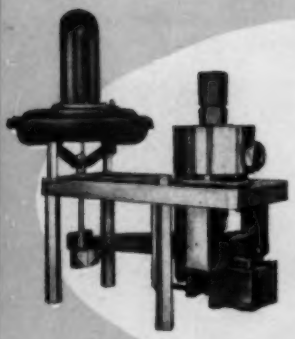


Butterfly Valves

Light and heavy duty types, with angle or swing-through seating, in spool or wafer body style, for low pressure air, gases in combustion control, steam, high pressure gases and liquids, etc. Available with Stabilflo Motor (shown) or cylinder operator.

Gate Valves

Guillotine-type slide valves, specially designed to handle pulp fibre, slurries, and similar fluids. Available with Stabiload Cylinder and Power Positioner as illustrated, for throttling service, or with 4-way pilot valve for on-off service.



Super-Pressure Valves

For throttling or let-down service up to 30,000 psi. Features an exclusive high-pressure bellows seal. Port sizes and connections to meet high pressure process specifications.

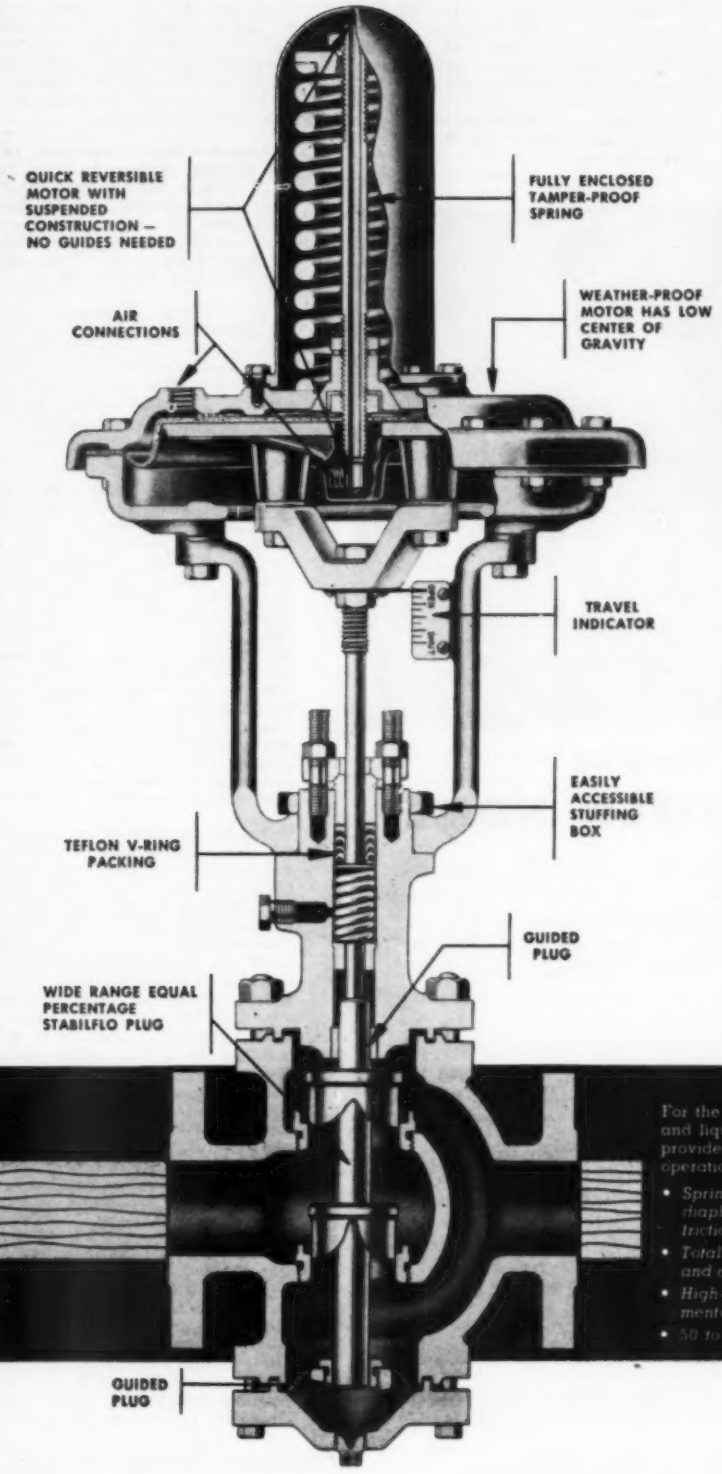
FOXBORO CONTROL VALVES

Reg. U.S. Pat. Off.

9 Strategic Branch Shops for Coast-to-Coast Service: Atlanta, Ga. • Pittsburgh, Pa. • Chicago (Skokie), Ill. • Dallas, Tex. • Houston, Tex. • San Francisco (San Leandro), Cal. • Los Angeles, Cal. • Montreal, Que. • Vancouver, B. C.

SOLUTION TO YOUR CONTROL VALVE PROBLEMS

...with Foxboro Pneumatic Control Valves

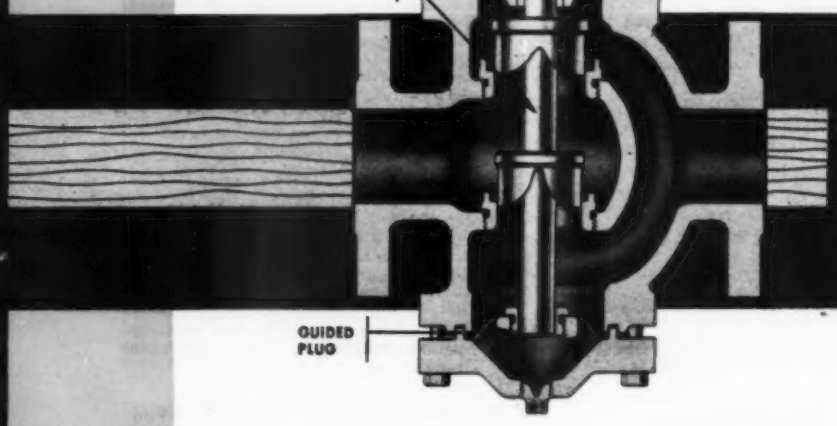

QUICK REVERSIBLE MOTOR WITH SUSPENDED CONSTRUCTION — NO GUIDES NEEDED
FULLY ENCLOSED TAMPER-PROOF SPRING
AIR CONNECTIONS
WEATHER-PROOF MOTOR HAS LOW CENTER OF GRAVITY
TRAVEL INDICATOR
EASILY ACCESSIBLE STUFFING BOX
TEFLON V-RING PACKING
GUIDED PLUG
WIDE RANGE EQUAL PERCENTAGE STABILFLO PLUG
GUIDED PLUG

You can always be sure of getting the control valve best suited to flow conditions and control actions when you specify Foxboro. No other single source offers such a wide variety of control valves for specific applications. None other has Foxboro's experience in applying them — in every phase of industrial processing.

Your choice extends from valves for simple on-off control at one extreme, to specialized proportioning control at the other; for high vacuum work to operation at 30,000 psi; for temperatures from −350° to +1000°F. And there's a wide choice of plug designs — and of alloys and trim to handle even severely corrosive and erosive fluids.

You can save shipping cost and time, too, buying direct from Foxboro's strategically located branch shops. They're staffed by experts.

A few typical control valves from Foxboro's complete line are illustrated here. For full details, or specific information on your problem, call your nearby Foxboro Field Engineer or write The Foxboro Company, 3811 Norfolk Street, Foxboro, Mass.



STABILFLO CONTROL VALVES

For the great majority of temperature, pressure, flow, and liquid level control applications, this basic valve provides unsurpassed sensitivity and troublefree operation. Unique design features:

- *Spring-above-diaphragm construction makes diaphragm motor self-aligning, virtually free from friction and hysteresis.*
- *Totally enclosed spring protects against tampering and corrosion.*
- *High-lift wide range V-port provides greater increment of lift for given change in air pressure.*
- *50 to 1 rangeability — equal percentage characteristics.*

WITH THE PIPELINE CONTRACTORS

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania. Also 39 miles of 4, 6, and 12-in. in South Louisiana for *Southern Natural Gas Company*. Laying gathering system in Lake Maracaibo, Venezuela, for *Creole Petroleum Corporation*, using concrete coated pipe up to 40 in. diam.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 miles 20-in. crude line for *Socony Mobil Oil Company de Venezuela*. Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast. Has contract for 42 miles, 24-in. in Louisiana for *Southern Natural Gas Company*. Has contract to build segments of a *Natural Gas Pipeline Company of America* line, consisting of 185 miles of 36-in. in Nebraska and Kansas, and 98 miles of 34-in. in Iowa.

● **Eastern Pipe Line Contractors, 820 Mercantile Building, Dallas, Texas.** Has 79 miles of 10-in. between Quartzsite and Yuma, Arizona, for *El Paso Natural Gas Company*.

● **H. C. Price Co., Price Tower, Bartlesville, Oklahoma.** Has contract for 42.7 miles of 30-in. in Kentucky and Ohio for *Texas Eastern Transmission Corporation*. Has 12 miles of 30-in. in Pennsylvania for *Texas Eastern Penn-Jersey Transmission Corporation*. For *Gulf Interstate Gas Company*, 133 miles of 30-in. in Tennessee and Kentucky. Has 121.6 miles of 20 and 24-in. for *Southern Natural Gas Company* in Alabama, Mississippi, and Georgia. Approximately 65 miles of 24-in. in Louisiana for *Transcontinental Gas Pipe Line Corporation*.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston 2, Texas.** Has 100 miles of 24-in. from Hughesville, Pennsylvania, to the Delaware River for *Transcontinental Gas Pipe Line Corporation*. Also has 30 miles of 30-in. for the same company between the Delaware River and Princeton, New Jersey.

● **O. R. Burden Construction Corporation, P.O. Box 5216, Tulsa, Oklahoma.** Laying 28 miles of 30-in. concrete coated pipe under Lake Pontchatrain in Louisiana for *United Gas Pipe Line Company*. Constructing gathering system in Jack and Wise counties, Texas, for *Natural Gas Pipeline Company of America* to connect 84 new wells.

● **R. H. Fulton & Company, Box 1526, Lubbock, Texas.** Has 21 miles of 26-in. from Fritch, Texas, northward, and 205 miles of 36-in. to a point near Meade, Kansas, for *Natural Gas Pipeline Company of America*, and will also build segments of the line from Offerle to Lincoln, Kansas. Has 47 miles of 10, 12, and 16-in. from Erick, Oklahoma, to Shamrock, Texas, and 15 miles of 30-in. in the vicinity of Jal, New Mexico, for *El Paso Natural Gas Company*. Also 50 miles of 30-in. for *Pacific Northwest Pipe Line Company* beginning near Opal, Wyoming, and extending northward to Big Piney, Wyoming. And 61 miles of 16-in. and 15 miles of 20-in. for El Paso Natural in states of New Mexico, Arizona, and Utah.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has 270 miles of 24 and 30-in. gas line loops for *Gulf Interstate Gas Company* in Louisiana, Mississippi, and Tennessee. Has 38 miles of 30-in. gas line for *Tennessee Gas Transmission Company* from the Gulf Coast to Ysclosky, southeast of New Orleans, Louisiana. Has Atchafalaya River crossing for *Transcontinental Gas Pipe Line Corporation* just north of Melville, Louisiana, consisting of one 30-in. and one 18-in. line. Has approximately 106 miles of 24-in. gas line for *Southern Natural Gas Company* in Mississippi and Alabama. Has 62 miles of 20-in. crude line for *Shell Pipe Line Corporation* from the vicinity of Nairn, Louisiana, north to Norco refinery above New Orleans. Also, 13 miles of 16-in. gas line for *Texas Gas Transmission Corporation* in the vicinity of Jennings, Louisiana.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta, Canada.** Laying 88 miles of 10 and 12-in. for *Federated Pipe Lines, Ltd.*, between Edmonton, Alberta, and Fort Assiniboine. This is the Southern Schedule of Federated's crude oil line from Swan Hills to Edmonton. Project includes four river crossings, North Saskatchewan, Pembina, Pembina Diversion, and Athabasca.

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Your employees want a home that's attractive, convenient and individual — not makeshift housing. And good field housing will attract and keep top quality employees.

Across the continent . . . even in isolated areas . . . you'll find distinctive WHITMOR field homes. And you'll find WHITMOR homes give you more for your money than any other housing on the market.

Whether you want a few houses or a complete small town with all utilities, streets, recreational building, swimming pool and tennis courts . . . WHITMOR can handle all your housing problems on one purchase order. Thirty-six years experience in homebuilding assures your complete satisfaction.

Investigate WHITMOR's unique "Lease-Rental Plan", which gives you the use of field homes without capital investment, just monthly rental.

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● **Oklahoma Contracting Company, P.O. Box 13227, Dallas 20, Texas.** Has contract for 130 miles of 24-in. between Lake Charles, Louisiana, and Baton Rouge, and 150 miles of 20-in. from Robstown to Bay City, Texas, for *Coastal Transmission Corporation*. Laying 100 miles of 30-in. for *Creole Petroleum Corporation* between Temblador and Caripito, Venezuela. Has 96 miles of 30-in. from Columbus, Mississippi, to the Tennessee River for *Tennessee Gas Transmission Company*.

● **Western Pipe Line, Inc., P. O. Box 1076, Austin, Texas.** Laying 112 miles of 24-in. and various size pipe in southern Louisiana for *Southern Natural Gas Company*.

● **Contracting & Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Has 81 miles of 36-in. for *Natural Gas Pipeline Company of America* from Cranston, Iowa, to Sheffield, Illinois. Laying 137 miles of 12-in. from Wood River to Champaign, Illinois, and 112 miles of 12-in. from Champaign to Griffith, Indiana, for *Wabash Pipe Line Company*.

● **Engelking and James, Ltd., Edmonton, Alberta.** Has 88 miles of 14-in., 3.5 miles of 16-in. and a total of 23 miles of various other lines for *Saskatchewan Power Corporation* from and in Success and Hatton gas fields in Saskatchewan.

● **Sharman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has approximately 28 miles of 30-in. concrete-coated pipe across Lake Borgne in St. Bernard Parish, Louisiana and Hancock County, Mississippi for *Tennessee Gas Transmission Company*. Has 38 miles of 30 and 24-in. for *Humble Oil & Refining Company*, about half of the company's Clear Lake to Port Arthur, Texas, natural gas line, extending from the Hankamer block valve to Port Arthur.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has undetermined amount of gathering system line for *El Paso Natural Gas Company* in the Four Corners area of New Mexico and Colorado. Has 22 miles of 20-in. in the Vinton, Louisiana, area, and 17 miles of 12-in. in the Lake Arthur, Louisiana, area for *Transcontinental Gas Transmission Corporation*. Also, an undetermined amount of various diameter lines in the Big Piney field near Kemmerer, Wyoming, for *Pacific Northwest Pipeline Corporation*.

● **Hunsaker Trucking Contractor, Inc., P.O. Box 97, Carrollton, Texas.** Stringing 21.5 miles of 12-in. from Cayuga to Fairfield, Texas, for *Bi Stone Fuel Company*.

● **Grayco Constructors, Inc., P.O. Box 4147, Austin, Texas.** Constructing 119 miles of 30-in. for *Tennessee Gas Transmission Company*, from Columbus to Heidelberg, Mississippi.

● **Midwestern-Waico Contractors, 105 North Boulder, Tulsa, Oklahoma.** Awarded contract by *Houston Texas Gas and Oil Corporation* to lay 30-in. main line between Baton Rouge, Louisiana, and Miami, Florida. Working three spreads: Denham Springs, Louisiana; Lacedale, Mississippi, and Vernon, Florida.

● **Latex Construction Company of Georgia, P. O. Box 12128, Atlanta 5, Georgia.** Has 22 miles of 14-in. for *Southern Natural Gas Company* from Bell Mills, Alabama, and Cedartown, Georgia, and 41 miles of 14-in. for same company between Macon and Griffin, Georgia.

● **Vaughn & Taylor Construction Company, Inc., P.O. Box 3266, Odessa, Texas.** Has 22 miles of 2 to 20-in. waterflood system near Monahans, Texas, for *Gulf Oil Corporation*.

● **Mannix Company, Ltd., 737 Eighth Avenue West, Calgary, Alberta, Canada.** Has 88 miles of 10-in. between North Bay and Sudbury, Ontario, for *Northern Ontario Natural Gas Company*. Laying 92 miles of 32-in. from Hearst to Kapuskasing, Ontario, for *Northern Ontario Pipe Line Crown Company*.

● **Macco Corporation, 14409 Paramount Blvd., Paramount, California.** Has 20 crews installing and replacing gas pipelines in Southern California area for *Southern California Gas Company* and *Southern Counties Gas Company*.

● **Mid-Mountain Contractors, Inc., 1310 Airport Way, Seattle, Washington.** Has contracted 17 miles of 8-in. between Pasco and Attalia, Washington, for *Cascade Natural Gas Corporation*. Also 9 miles of 4 and 6-in. for *Washington Natural Gas Company* in Kings County, Washington.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Trojan Construction Company, Inc., 1416 N. Robinson, Oklahoma City 3, Oklahoma.** Has contract for take-up and reconditioning of 140 miles of 12-in. and 140 miles of 8-in. pipe from Teague to Huffman, Texas, for *Sinclair Pipe Line Company*.

● **Engineers Limited Pipeline Company, 225 Bush Street, San Francisco 4, California.** Has 102 miles of gathering lines in Aneth field, Utah, for *El Paso Natural Gas Company*.

REILLY

NEW 230 X-1

PRIMER

1. Reilly announces a Plasticized Coal Tar Enamel Primer, designed for maximum bond development.
2. Quick-drying (20 minutes± has been reported).
3. Non-sagging and non-curtaining.
4. Great coverage (750 to 1400 square feet per gal.).
5. Stability of bond — no degradation of bond with time and temperature exposure.
6. Derived wholly from coal tar materials, thus fully conforms to A. W. W. A. and governmental agency standards.
7. Gives 100% reliability factor to coating process when properly applied with plasticized coal tar enamel.

. . . . *More to come. Reilly 230 X-1 Primer is the first of a series made possible by a significant break-through in applied coal tar surface chemistry. HS X-1 for Reilly Hot Service Enamel and QD X-1 for Reilly Intermediate Enamel will soon be available.*

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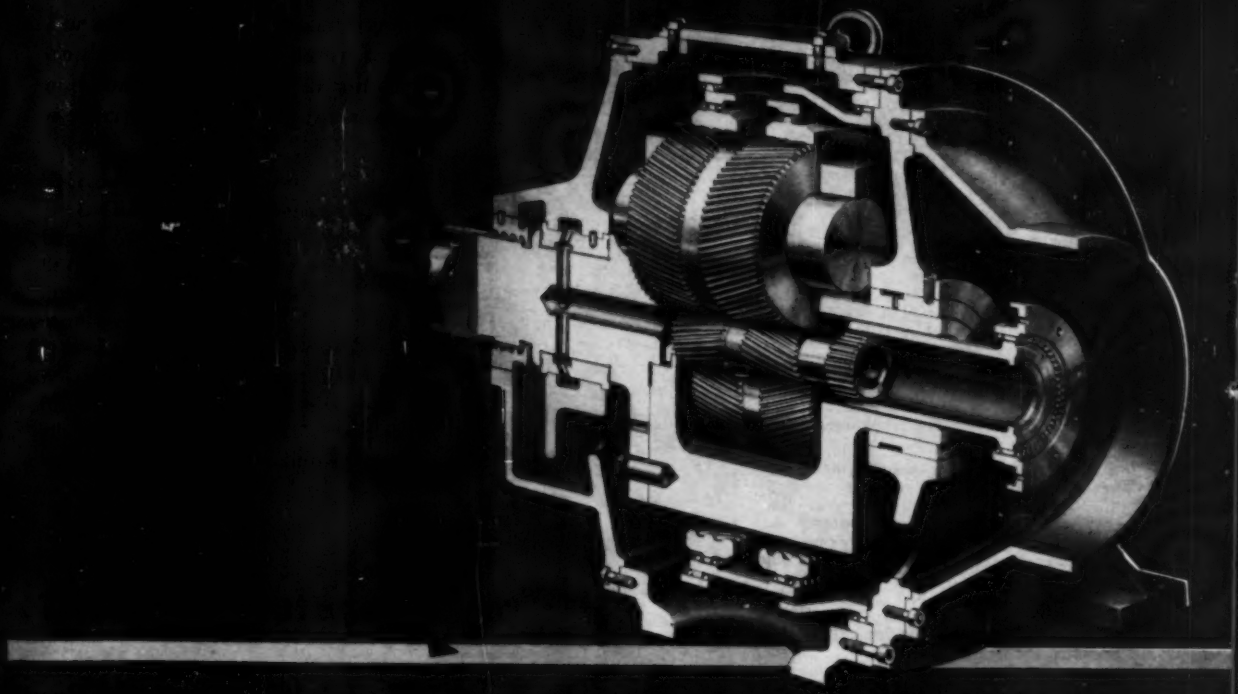

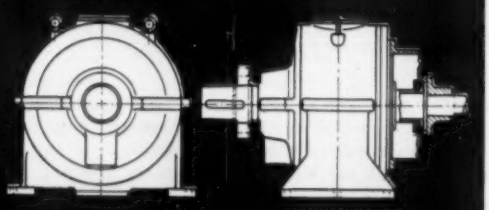

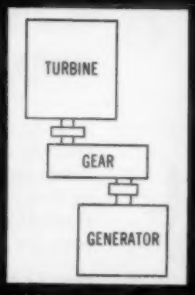

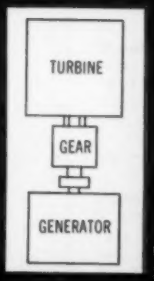

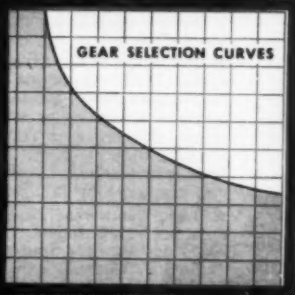

DE LAVAL

PIPELINE PERSONALS

Dwight B. Sprow has been appointed executive vice president of Houston Texas Gas and Oil Corporation and will serve in a similar capacity for Coastal Transmission Corporation. Other appointments announced include: **Don A. Hardesty** as superintendent of pipelines for both corporations; and **J. B. Zachry** as compressor station superintendent for both corporations.

Sprow formerly was vice president and operating superintendent for the Natural Gas Pipeline Company of America, the Texas-Illinois Natural Gas Pipeline Company, and the Natural Gas Storage Company of Illinois. Hardesty has been vice president, employee and public relations, for the above three companies, and Zachry has been employed for the last 23 years by Worthington Corporation.

D. B. Sprow

D. A. Hardesty

J. B. Zachry

Keith Bentz

Keith Bentz, superintendent of pipelines for Texas Illinois Natural Gas Pipeline Company, has been elected assistant vice president of operations of that company and it is expected that he will be elected to the same office of the affiliate, Natural Gas Pipeline Company of America. Another appointment for both companies is **D. T. Lutz** to direct the activities of the employee relations and public relations divisions. Prior to his appointment, Lutz was field superintendent of compressor stations for TING at Malvern, Arkansas.

F. E. Stanley, chairman of the board and president of The Houston Corporation, has named **G. B. Bennett** vice president in charge of sales and operations for distribution properties. Bennett also will be vice president in charge of sales for the Houston Texas Gas and Oil Corporation.

Clyde C. Phillips, vice president and a director of the Ohio Fuel Gas Company, has retired, closing a 49-year career with the firm. Phillips, since 1929, has managed the transmission department. He was elected a director in 1946 and vice president in 1950.

R. Dean Grimm has been promoted to the position of manager of the gas supply department, Northern Natural Gas Company. Grimm is former manager of gas reserves and availability and underground storage.

Natural Gas Pipeline Company of America, Texas Illinois Natural Gas Pipeline Company, and Natural Gas Storage Company of Illinois, all affiliates, announce eight appointments: **Hobert E. Boomer,** superintendent of pipelines of Texas Illinois in Chicago; **Dale A. Schafersman,** field superintendent of compressor stations with headquarters in Malvern, Arkansas; **Burman F. Olson,** superintendent of Station 201 of Natural Gas Storage Company near Herscher, Illinois; **William P. Lincoln,** assistant superintendent of Station 112 and Gasoline Plant 152, Natural Gas Pipeline, Stinnett, Texas; **C. J. Fitzgerald,** superintendant of Natural Gas Pipeline's Station 108, —Truro, Louisiana; **Marion E. Shelor,** superintendent of Station 103, Minneola, Kansas; **Robert D. Means,** superintendent of Texas Illinois' Station 304, Marshall, Texas; **George R. Brindle,** district superintendent of gas measurement, Natural Gas Pipeline, with headquarters at Fritch, Texas.

H. E. Boomer

D. A. Schafersman

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KELLEY RIPPER

The C-R-C Kelley Ripper, D-9 Caterpiller size, rips 6' deep through laminated rock ahead of the ditching machine, with savings in time and cost per ditch. Hydraulic or cable-operated C-R-C Kelley Rippers are available also in sizes to fit D-8 and D-7 class tractors. Write or call Crutcher-Rolfs-Cummings, Inc., at 7825 Katy Road, Houston, Texas, UNderwood 4-6391.

- Mounts on Transmission Case
- Pulls from Tractor Draw-bar
- Holds Positive Ripping Depth
- Speeds Up Ditching Operations
- No Wider Than Tractor
- Heat-treated Oil Drawn Steel Shanks
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For additional information see Page 107, Pipe Line Composite Catalog.

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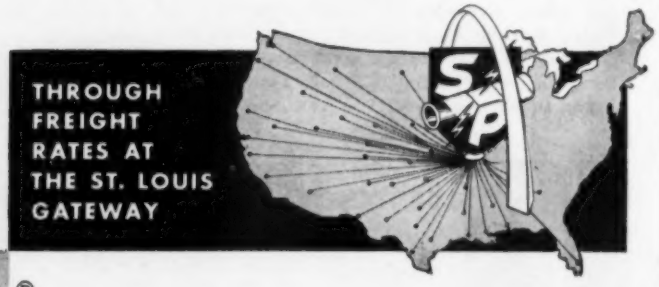
When your pipe has been coated and wrapped in our plant in accordance with procedures that establish the highest standard of quality for pipe protection, its kraft wrapper displays this hallmark of quality.

Whenever and wherever you see it, you may be assured of the finest pipe protection by Standard Pipeprotection.



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Personals

Clint D. Rogers has been named vice president in charge of the transmission division by Cities Service Gas Company, Oklahoma City, Oklahoma; **Russell W. Hofsess** has been promoted to vice president in charge of the production and supply division, and **John L. Gere** to head the engineering and research division. Formerly, Rogers was manager of transmission, Hofsess was manager of production and supply, and Gere was chief engineer. All three executives are veterans in the gas industry and are members of the company's board of directors.

C. D. Rogers

R. W. Hofsess

J. L. Gere

Charles I. Francis has retired as vice president and general counsel of Texas Eastern Transmission Corporation. **Jack D. Head,** Houston attorney, has been named to succeed him. Francis has been vice president, general counsel, and a director of the company since 1947.

Charles W. Guy has rejoined General Gas Corporation, Baton Rouge, Louisiana, as executive vice president and member of the board of directors. He also will serve in similar capacities with Delta Tank Manufacturing Company, Inc. Guy was executive vice president and director of General Gas prior to his resignation in 1954.

Robert M. Olson Jr. has been named assistant counsel of Southern Counties Gas Company. Olson, formerly secretary and trust officer of Security Title Insurance Company, of Los Angeles, succeeds **Joseph R. Rensch,** now assistant vice president and special counsel of Pacific Lighting Gas Supply Company.

Howard B. Cary has resigned his position as assistant general works manager of the Marion Power Shovel Company to become director of the newly established Hobart Brothers Technical School in Troy, Ohio. Cary will direct the institution in its program of teaching, research, and development in the welding field.

George C. Roth has retired as director and vice president of operations for Cities Service Gas Company, Oklahoma City, Oklahoma, completing a 45-year career with the company. Roth first came to the organization now known as Cities Service in 1913 and worked as expense ledger auditor, clerk in sales, pipeline and gas transmission departments, and as chief clerk of the Kansas Natural Gas Company until 1922. From 1922 to 1953 he was assistant to the superintendent of operations, supervisor of gas sales department and assistant to operations manager for Cities Service Gas Company. He was named vice president in 1953. He also served as director and vice president of Cities Service Gas Producing Company, a subsidiary.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

▸ All officers of the Michigan Gas Storage Company were re-elected at the annual organization meeting of the company's board of directors in Jackson. They are: President, **Dan E. Karn;** vice presidents, **Robert P. Briggs** and **John B. Simpson;** controller, **John W. Kluberg;** secretary, **Walter R. Boris;** treasurer, **George E. Olmsted,** and **Cecil I. Jones,** assistant controller; **Edward C. Wilkins,** assistant secretary, and **W. Howard Hoover,** assistant treasurer. Michigan Gas Storage Company is a subsidiary of Consumers Power Company engaged in storing and transmitting natural gas. The company's directors are Karn, Briggs, Simpson and **Justin R. Whiting,** all of Jackson, and **William G. Maguire, Frederick H. Robinson** and **Edwin Thorne,** of New York City.

▸ **Reinhard H. Meyer** has retired as chief accountant, Sinclair Pipe Line Company, Independence, Kansas. **John L. Roberts,** assistant chief accountant, was named to succeed Meyer as chief accountant.

▸ **Guy T. Henry,** president of the Providence Gas Company, and **Paul R. Haas,** administrative vice president of Texas Eastern Transmission Corporation, have been elected members of the board of directors of Algonquin Gas Transmission Company.

THE NEW MINIATURIZED

WILKINSON Line Locator Model W-3

This radically new, powerful transistorized sub-surface locating instruments weighs only four pounds and is one-fourth the size of conventional pipe locators.

It's as handy as a flashlight; the transistors will rarely ever require replacing; non-leak mercury cells will last at least ten times longer. The maintenance is trivial. Molded glass fibre instrument cases insure maximum protection. The aluminum connecting handle telescopes to 17" and the entire instrument is packed in a substantial carrying case.

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Important H & M Accessories:

THE OUT-OF-ROUND MOTORIZED UNITS | SHAPE CUTTER BOXES AND DOLLIES | FLEXIBLE SHAFT HOOKS, CLAMPS

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RESISTS BENDING, GOUGING, ABRASION

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Test certificate furnished.

A Brinell hardness of 265-285 assures higher resistance to bending... gouging... abrasion. Short, stubby links provide greater flexibility—snugger grips. Patented Tayco Hooks—with unique I-Beam type design—mean greater overall strength—longer life. Try TM Alloy Boomer Chain and see the big difference! Call your supply store or write for Oil Field Bulletin.

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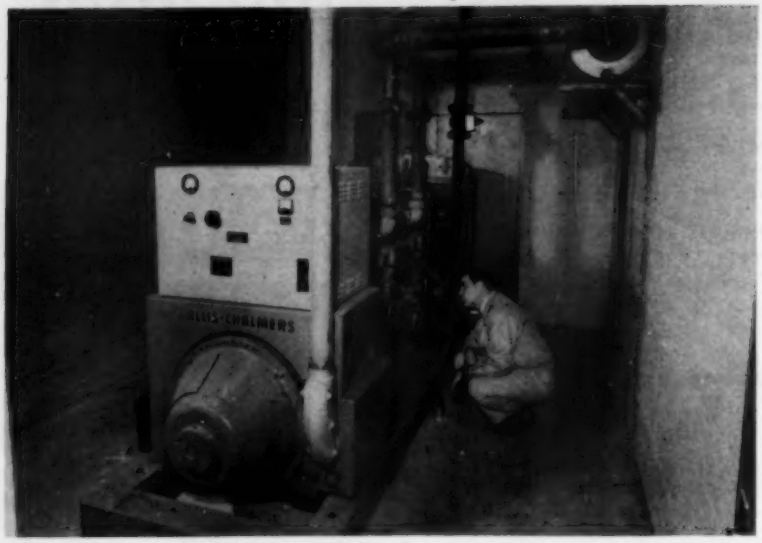
Pipeline Equipment

Generates Continuous Or Standby Service



A new standard line of 5 to 500-kw a-c or d-c engine generator sets, in single or three phase, 50 or 60 cycle frequency, are now available through Allis-Chalmers. Drives are diesel, gasoline, butane, or natural gas engines. Switchboards (control panels) for the standard units are available for mounting on the set, on the floor or wall, or in a base cubicle set on the floor.

In addition to the standard models, a new high-speed synchronous generator is available with diesel engine drive for 30 to 300-kw standby or continuous service. It can be driven at 1200 or 1800 rpm. *Allis-Chalmers Manufacturing Company.*

Circle number (81) on reply card.

Gage Hole Cover Improvements

S&J Figure 5008 is a new steel plate gage hole cover with a flexible, leak-proof safety seal ring that prevents vapor loss and assures a tight seating. It eliminates spherical machining on seat and cover, the worry about a water-tight joint, and the problem of corrosion. The handle offers quick opening by either hand or foot. *Shand and Jurs Company.*

Circle number (82) on reply card.

Travel-Crew Cab

International Harvester Company announces a new six-passenger Travel-Crew truck cab, now available on certain Inter-

national medium and heavy-duty truck models. It is described as roomy, yet increasing bumper-to-back-of-cab dimensions on all models by only 36 in. *International Harvester Company.*

Circle number (83) on reply card.

Mercury Switch Weighs 1.8 Grams

A new capsule-size mercury switch that weighs only 1.8 grams with leads attached has been introduced for use in computers, scales, electronic organs, and other devices where a minimum of operating energy is available and space is limited. The extremely low shift of mass involved in actuation facilitates gang-mounted assemblies. *Micro Switch Division, Minneapolis-Honeywell Regulator Company.*

Circle number (84) on reply card.

Gages Liquid Levels In Enclosed Containers

Ability to measure level of liquids in totally enclosed containers and determine amount of natural gas in underground storage cavities are among the applications of a new Continuous Level Gage, Model 40104.

A small radioactive source contained in a float follows the level of liquid along a path predetermined by guide lines placed inside the tank. Radiation emitted by the source is detected by a scintillation detector located outside the tank. Changes in the level of the liquid cause changes in the strength of radioactivity detected. This change is then calibrated in linear distance or volume. To determine the amount of natural gas, the gage measures the level of water pumped into the cavity to force out the gas. *Radiation Counter Laboratories, Inc.*

Circle number (85) on reply card.

Copper-Thermite Connections

The Thermoweld electrical connection of welding copper to copper or copper to steel in cathodic protection installations, is being introduced.

Thermoweld connections utilize the high temperature of reaction that takes place when powdered copper oxide and aluminum are ignited in a graphite mold. When the reaction takes place superheated liquid copper flows over the conductors in the mold forming a fusion weld between them. In making Thermoweld connections no outside source of power is required. *Continental Industries, Inc.*

Circle number (86) on reply card.

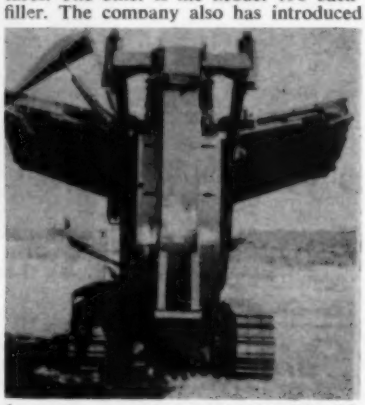
Heavy Duty Welder, Attachment Announced

A new 600-amp d-c heavy duty welder for arc and stud welding is available with either a gasoline or diesel engine power source. A paralleling attachment is also available to facilitate combining two units for 1200-amp capacity in stud welding, automatic welding, arc air cutting, etc. The attachment has a magnetic contactor, controlled by a push button and by a protective current relay, with a light to indicate when the contactor closes. Should the two machines become badly unbalanced, current will flow in the equalizer circuit, tripping the protective relay, which trips the contactor. *Hobart Bros. Company.*

Circle number (87) on reply card.

New V-Shaped Conveyor

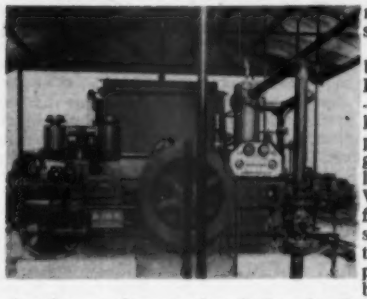
Cleveland Trencher's Model 240, shown here, is one of two machines already in the Cleveland line which has undergone major design improvements and new features. The other is the Model 190 backfiller. The company also has introduced



four new wheel-type trencher models with a new-type V-shaped discharge conveyor. The Model 240 now employs the same V-type conveyor construction with the same V-shape advantages as the new J-series models. Model 240 digs to 3 ft wide to 6 ft 3 in. deep. Its 12-ft by 30-in. conveyor power-folds down to within trencher's overall 8-ft width. Hydraulically powered shifting and folding of conveyor are lever-controlled from operator's seat. *The Cleveland Trencher Company.*

Circle number (88) on reply card.

Compressors to Meet Gas Gathering Demands



many design and construction innovations Highlighting the built into the new DPC-230 compressor —the first of a new line of horizontal, opposed-cylinder gas engine-compressors released by Ajax Iron Works—is the massive four-throw crankshaft, mounted on three double-row tapered roller main bearings, having engine throws of greater length than for the compressor side. The arrangement permits piston speeds for optimum efficiency of the compressor while obtaining maximum power and fuel economy from the power side. *Ajax Iron Works.*

Circle number (89) on reply card.

Pump for Leakless Handling

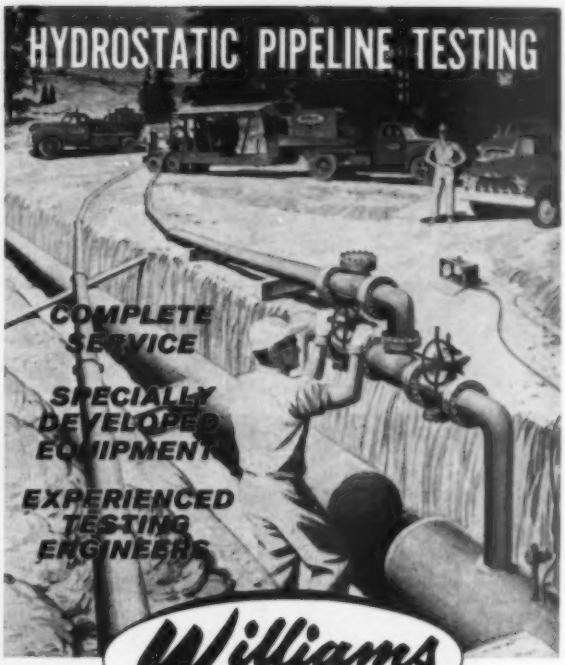
An "Electri-Cand" single-stage, single-suction pump, air-tight and requiring neither mechanical seal nor packing, has been announced for leakless handling of all liquids. Designed for handling costly or volatile substances at temperatures to 200 F, the pump is available in capacities to 500 gal per min at heads to 250 ft. *Allis-Chalmers Manufacturing Company.*

Circle number (90) on reply card.

New Needle Valves for Fluid Control

A new line of high pressure, high temperature fluid control needle valves has been announced. Engineered for operation under working pressures up to 5000 psi, in temperatures ranging from minus 60 F to plus 450 F, the new line is equipped with "Hi-Seal" tubing connections which eliminate separate fittings and leakage possibilities. Telfon packing is used for positive sealing, and there are no rubber "O" rings to replace due to aging and swelling. *The Imperial Brass Mfg. Company.*

Circle number (91) on reply card.



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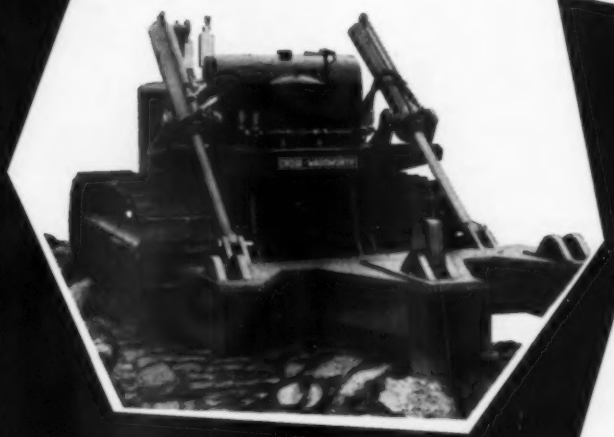

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New Equipment

Junior Emergency Pipe Clamp

The Junior Emergency Pipe Clamp, a new companion to the Emergency Pipe Clamp, is made up in single bolt width,

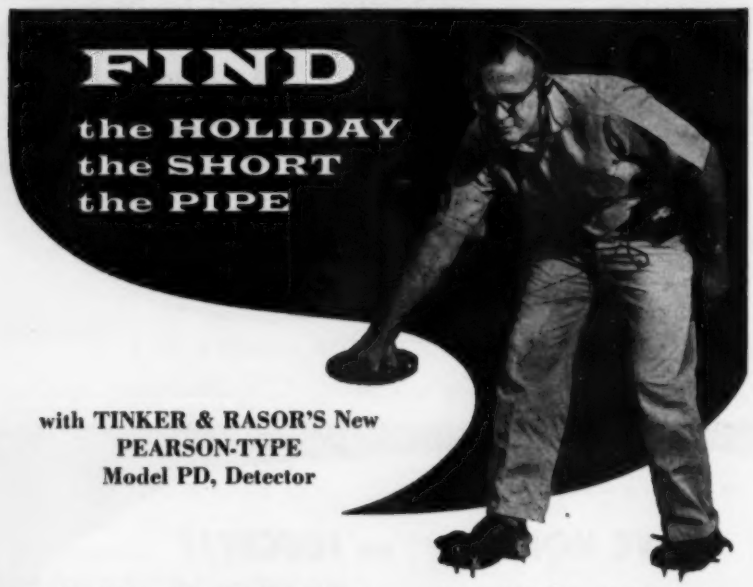
instead of two bolt width and is only 2⅛-in. wide. It is made of malleable iron, has a full-length hinge along one side, a single oversized plated bolt on the other. The "top" half is a little narrower than the "bottom" or gasket half of the clamp. Among its new features: The lug on the gasket half is slotted for quick "bolting." Installation is quick. *M. B. Skinner Co.*

Circle number (92) on reply card.

Zip Chain Saw

Felling 18-in. trees in 18 seconds is the speed of the new Zip chain saw announced by Homelite. With blades in a variety of sizes, ranging from 12 to 21 in. the Zip chain saw incorporates short-stroke engine design, all position diaphragm carburetor, automatic clutch and safety chain guard, and large air filter and fuel tank. *Homelite.*

Circle number (93) on reply card.



with TINKER & RASOR'S New
PEARSON-TYPE
Model PD, Detector

Tinker & Rasor have developed a new, compact, highly effective, all transistor, Pearson-type detector. This instrument, the Model PD, produces a 15 watt, 750 cycle audio signal on a buried pipeline. This signal can be clearly heard through a new T & R 4-stage, transistor receiver, small enough to be worn on the operator's belt. Through sharp filters, this new receiver rejects unwanted 60 cycle signals. The receiver weighs but 14 oz. and draws 800 micro amperes from a 4-volt mercury battery. The Model PD detector makes it possible to follow a buried pipe, to locate holidays in that pipe's protective coating as well as any electrical shorting between the pipe and other metal structures.

All components except oscillator storage battery are supplied in a sturdy carrying case.

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DISTRIBUTORS: Crutcher-Rolfs-Cummings, Inc., Houston, Texas, Remco Manufacturing Co., Inc., Tulsa, Oklahoma, Canadian Equipment Sales and Service, Ltd., Edmonton, Alberta, Bob Herrick, Rentals and Service, Harrisburg, Penna., Falcon Line Products Corp., Elizabeth, New Jersey • Export Agents: Frazar and Hansen, Ltd., San Francisco.

New Seat Irons Out Bumps

The Torsionflex seat, which is designed to iron out the bumps of the haul road, has been made available by Caterpillar Tractor Company on its complete line of rubber-tired tractors. Two shock-dampening features are rubber torsion springs and double-acting hydraulic shock absorber, plus rubber snubbers. Seat belts are standard equipment for safety on the DW20 and DW21 Torsionflex seats. *Caterpillar Tractor Company.*

Circle number (94) on reply card.

Adjustable Blades On Trowel

A new 39-in. power trowel for floating and finishing concrete slabs has been introduced. It has adjustable 7 by 13-in. blades which can be altered for proper pitch while the machine is in motion simply by operating a handle control. Other design features include low center of gravity, uni-frame construction, blade-center suspension, automatic clutch, and non-rotating guard ring. *Thor Power Tool Company.*

Circle number (95) on reply card.

Joint Molds

Dearborn Chemical Company has announced exclusive United States distributorship of P. C. Joint Molds, the use of which will allow the coating of joints and cutbacks with the same material and manner of application as mill-coated pipe, including the bottoms of joints, for complete protection from corrosion. *Dearborn Chemical Company.*

Circle number (96) on reply card.

Dozer-Loader Combination

A new 2-in-1 combination ⅝-yd loader and dozer, the 42-hp Case Utility 310 Crawler-Loader-Dozer provides two heavy-duty tools for digging, loading, levelling, pioneering, etc. Vertical connecting arms between loader and dozer serve as lift when operating the full-size blade. Switching to loader operation takes

only five minutes to pull four pins in connecting arms and involves no change in the single, powerful hydraulic system that operates both tools. Even wider-range versatility may be added by equipping with optional rear-end attachments. *J. I. Case Company.*

Circle number (97) on reply card.

Telegraph Terminal Has Plug-In Modules

A transistorized audio frequency shift terminal, Model 1220 Comtel, is capable of transmitting data at speeds up to 250 words per min and is of modular design, with plug-in component modules that can be arranged for either dual transmitter, dual receiver, or transmitter-receiver on a single 19½-in. by 5¼-in. rack mounting chassis. The unit may be used in telegraph, telemetering, and control applications requiring either voltage, current, or dry contact keying. *Radio Frequency Laboratories, Inc.*

Circle number (98) on reply card.

NEW PIPELINE LITERATURE

Catalog Expands Pipeline Data

A newly revised 48-page catalog of pipeline fittings includes full dimensional data on full-encirclement saddles, anchor forgings, gas distribution fittings, 125-lb lightweight taper-face flanges and 900-lb welding neck, slip-on and blind flanges. Tube Turns' Bulletin TT-638R, containing substantially more data than earlier editions, also expands allowable working pressure tables for gas transmission and distribution piping to provide values for construction type design factors A, B, C, and D. Allowable working pressures are given for gas distribution fittings. Special pipeline fittings such as 3R elbows, venturi reducers, pig diverter laterals, scraper bar tees, and manifold fittings are also listed in the new edition. *Tube Turns.*

Circle number (99) on reply card.

Fibercast Line Pipe

A complete engineering data and general information booklet, in color, on chemical and line pipe, tubing and fittings, covers such subjects as: What it is; production quality control; pipe strengths; engineering data and charts; chemical resistance; specifications; installation procedures, and applications in the chemical, petroleum and other industries. *Fibercast Company.*

Circle number (100) on reply card.

Seal for Floating Roofs

A "performance checklist" and design features highlight an illustrated, 4-page brochure describing the Horton Fabric Seal for floating roof tanks. *Chicago Bridge & Iron Company.*

Circle number (101) on reply card.

Open-Type Motors

"Super-Seal" open-type motors suitable for many applications are described in a new bulletin released by Allis-Chalmers, and examples are given of how motor saves 30 percent on a typical pump drive. Available in all integral horsepower frames, the motors are unaffected by moisture, dust, dirt, oils, acids and alkalies. *Allis-Chalmers Manufacturing Company.*

Circle number (102) on reply card.

Four Axle Truck Crane

Highlighting an illustrated 8-page catalog is the design and operating features of the new Lima Type 64-T 50-ton capacity truck crane. The Lima designed carrier construction, "pin-on" type front and rear outrigger boxes, hydraulic power steering, compact heavy-duty rotating assembly, independent planetary boom hoist, main machinery, folding gantry and pin connected boom are illustrated and described. *Baldwin-Lima-Hamilton Corporation—Construction Equipment Division.*

Circle number (103) on reply card.

Versatile Compressors

A color bulletin describes 2 new single-stage centrifugal compressors, Model OM and OPB, that can be used for blower service where inlet conditions are atmospheric; for exhauster service where inlet conditions are below atmospheric pressure or for booster service when inlet conditions are above atmospheric pressure. The design features are detailed. *Clark Brothers Company.*

Circle number (104) on reply card.

Pulsation Reducer

Equipment designed to reduce pulsations in liquid lines caused by reciprocating or rotary pumps to 10 percent or less, with a pressure drop as low as 5 ft of liquid, is described in a new bulletin. Known as the Pulso Liquid Pulse Trap, it is said not only to subdue pipeline vibration but to eliminate meter errors, improve volumetric efficiency of the pump, and reduce maintenance costs. *Pulsation Controls Corporation.*

Circle number (105) on reply card.

Flexible Pumps

A line of single-stage double-suction centrifugal pumps with horizontally split cases, available in all sizes with oil lubricated bearings, is described in Bulletin 721.6, issued by Goulds Pumps, Inc. In addition to the wide range of capacities and pressures, a high degree of standardization and interchangeability of parts distinguishes these pumps, giving minimum inventory of spare parts and flexibility of changes in the field to meet new requirements and low initial cost. *Goulds Pumps, Inc.*

Circle number (106) on reply card.

Accurate pH Measurements

Techniques for making accurate pH measurements in usually troublesome samples such as soils, emulsions, suspensions and oils are covered in a new data sheet. Proper care of pH electrodes is discussed, and three separate procedures are outlined for proper soil pH measurements. *Beckman Instruments, Inc.*

Circle number (107) on reply card.

Welding Supplies In 100 Pictures

A new 52-page welding supplies and accessories catalog, illustrated with over 100 photographs, covers a complete line of fluxes and ferrous and non-ferrous rods for gas welding; and accessory items including protective clothing, goggles, electrode holders, sparklighters, cable, hose, weld cleaning tools, cylinder trucks and many other items, for both arc and gas welding. *Air Reduction Company, Inc.*

Circle number (108) on reply card.

Turbine Type Flowmeter

The Pottermeter, a turbine type flowmeter with a patented floating rotor as its only moving part, is described in a new bulletin. The flowmeter is said by its manufacturers to give long-term, trouble-free service for pipelines, loading racks, bulk plants, and refineries, and well suited for automatic custody transfer. *The Pottermeter Company.*

Circle number (109) on reply card.

Color Booklet Gives Tips On Track Shoes

An illustrated, 8-page discussion of track shoes and hardware has been released by Caterpillar Tractor Company. In this 2-color Form DE-844, available in English, Spanish, French, or Portuguese, the reader will find photographs, drawings, and diagrams, and useful information on the selection and rebuilding of track components, as well as charts showing optimum time at which grousers should be built up and torque specifications for the correct tightening of hardware. *Caterpillar Tractor Company.*

Circle number (110) on reply card.

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Trans-Canada Pays More for Gas Under New Contract

Trans-Canada Pipe Lines, Ltd., has made the first gas purchase contract at increased rates since its first batch of sign-ups at the original 10-cent rate.

The new contract is with Canadian Delhi Oil, Ltd., for a small daily volume of gas from the Medicine Hat field in southeastern Alberta. The initial price is 13¼ cents per MCF, escalating ¼-cent per MCF per year for the 26-year term to a maximum of 18¾ cents. The volume is only within a range from 6,500,000 to 8,600,000 cu ft per day, but the price is considered symptomatic of what may be expected for all producers on future contracts. It has been hinted by executive officers of the local utility companies in Alberta that future sales will be made under escalation scales up to 22 cents, and that the contracts will contain "most favored nation" clauses under which any higher scale specified in a subsequent contract with any producer will automatically be introduced into all existing contracts containing the clause.

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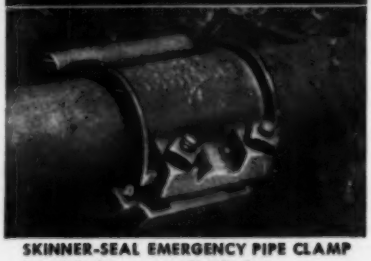

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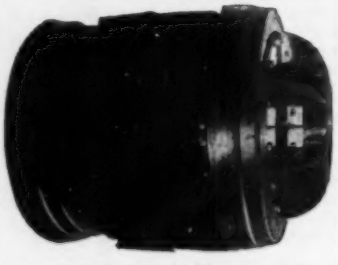

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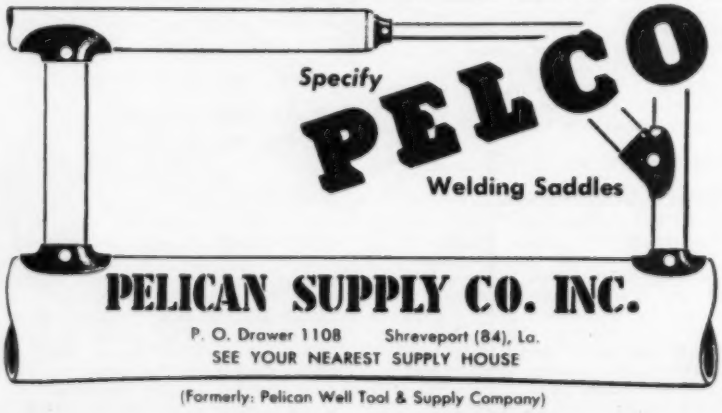

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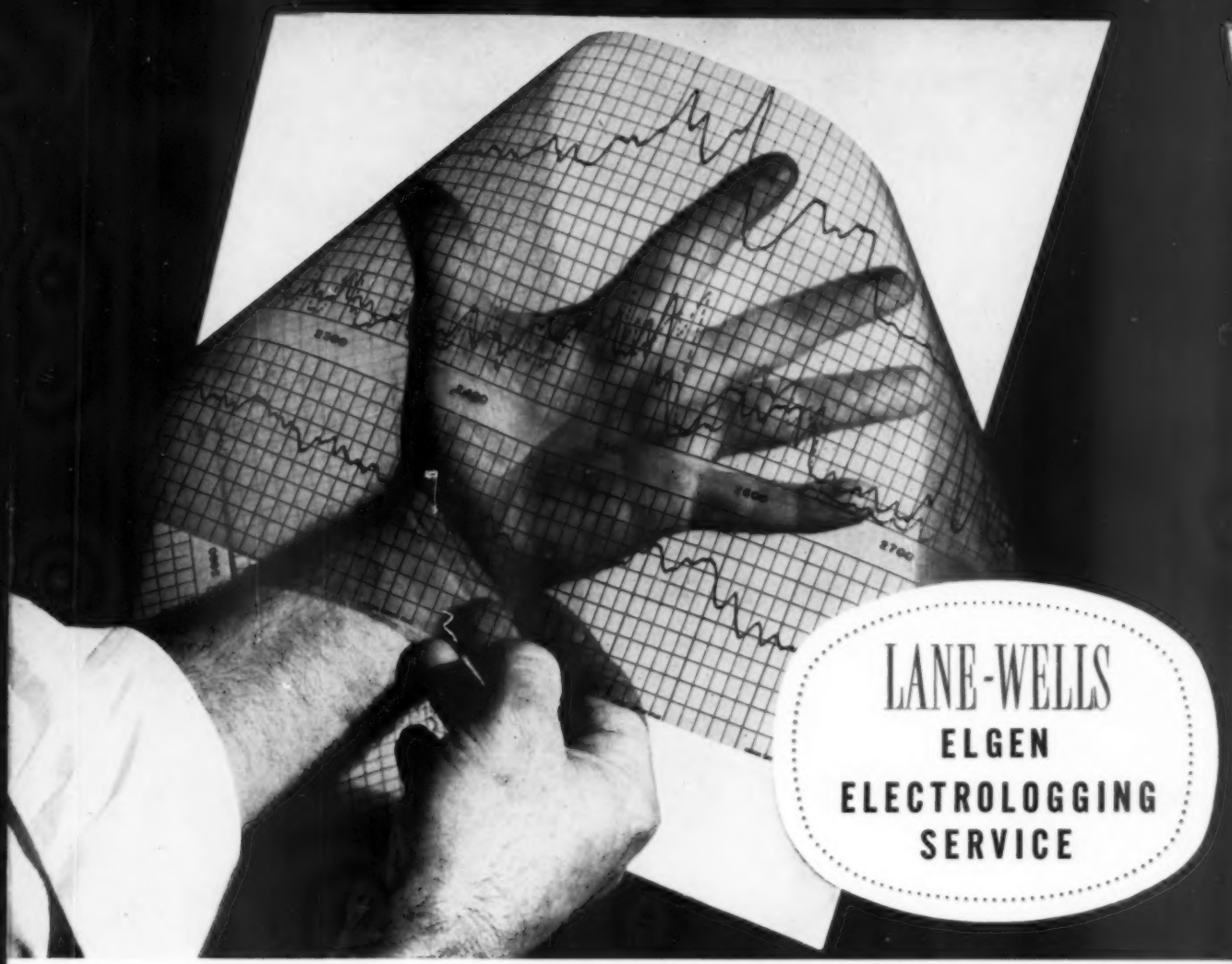

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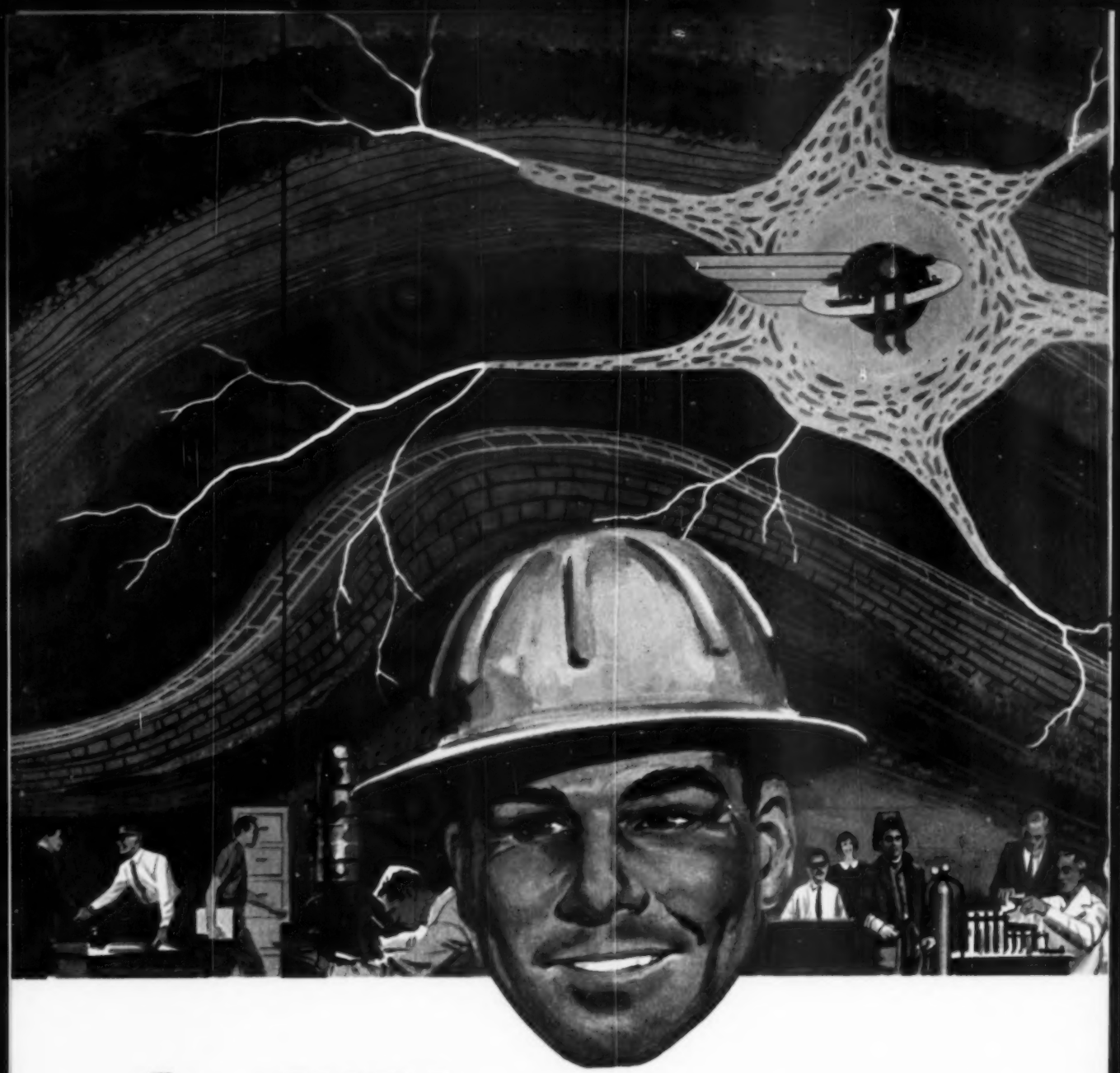

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